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A KEY TO DIAGNOSIS AND PROGNOSIS OF NEOPLASTIC LESIONS OF BONES[1]

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THOSE of you who are familiar with the literature and the discussions of neoplastic lesions of bones know that much confusion exists concerning the subject. This is probably due to: (1) the multiplicity of useless, meaningless, and synonymous names for lesions, the natural result of rapidly growing, unco-ordinated, and uncorrelated knowledge of disease; (2) poor, antiquated, and inadequate methods of histologic study, such as fixation and embedding, both of which have their place but are inferior to fresh tissue methods in the study of cells; (3) lack of intimate co-operation and correlation between surgeons and pathologists, and (4) natural conservative, pedagogic adherence to traditional terminology and classifications, a method by which we maintain progress but do not necessarily make progress.

Critical as this enumeration may seem, there is, nevertheless, sufficient truth to arouse in all of us the only means of advancing knowledge, namely, open-mindedness, continued observation, and correlation. The problems of diagnosis, prognosis, and therapeutics relative to lesions of bones are not settled and probably will not be until there is a new approach to the subject. The approach I wish to suggest may be by no means final but it has been tried as a guide to treatment and prognosis with success over a long period of years.

Before a prognostic diagnosis of bone lesions can be made they should be divided into four clinical groups:

1. Visible or palpable masses, which frequently follow injury without fracture and without the usual clinical signs and symptoms of infection. Roentgenograms of these cases show the contour and consistency of the bone and often of the surrounding soft tissues, to be altered. This group offers little difficulty in prognosis.

2. Small lesions, not necessarily so easily seen or felt but which, on account of pain, discomfort or reduction of function, are not seen without the signs and symptoms of infection. On roentgen-ray examination these show some alteration in the normal configuration of the bone and its consistency, with or without involvement of soft tissues.

3. Lesions that are associated with signs and symptoms of low-grade infection. On roentgen-ray examination these show mottled, irregular shadows, with destruction of bone.

4. Lesions that are a part of the bone or cartilage, or are definite outgrowths of either. On roentgen-ray examination these are found to have smooth contours and the consistency of cartilage or bone.

Any one of these pictures may appear at

[1]Read before the Radiological Society of North America, at Milwaukee, Wisconsin, December 3, 1926.

any age, in any bone or in any portion of a bone. All conditions are, of course, most easily seen by means of the roentgen ray, but a correct diagnosis and prognosis cannot always be made by this means. The problem is: Are we dealing with an inflammatory condition, or a benign or a malignant neoplasm? The treatment is dependent on the prognostic diagnosis. The clinical history, physical examination, and roentgenograms can differentiate these groups prognostically in many instances; in how many it would be difficult to determine. There is always an appreciable minority of cases that cannot be correctly differentiated. It is in the prognostication of this minority

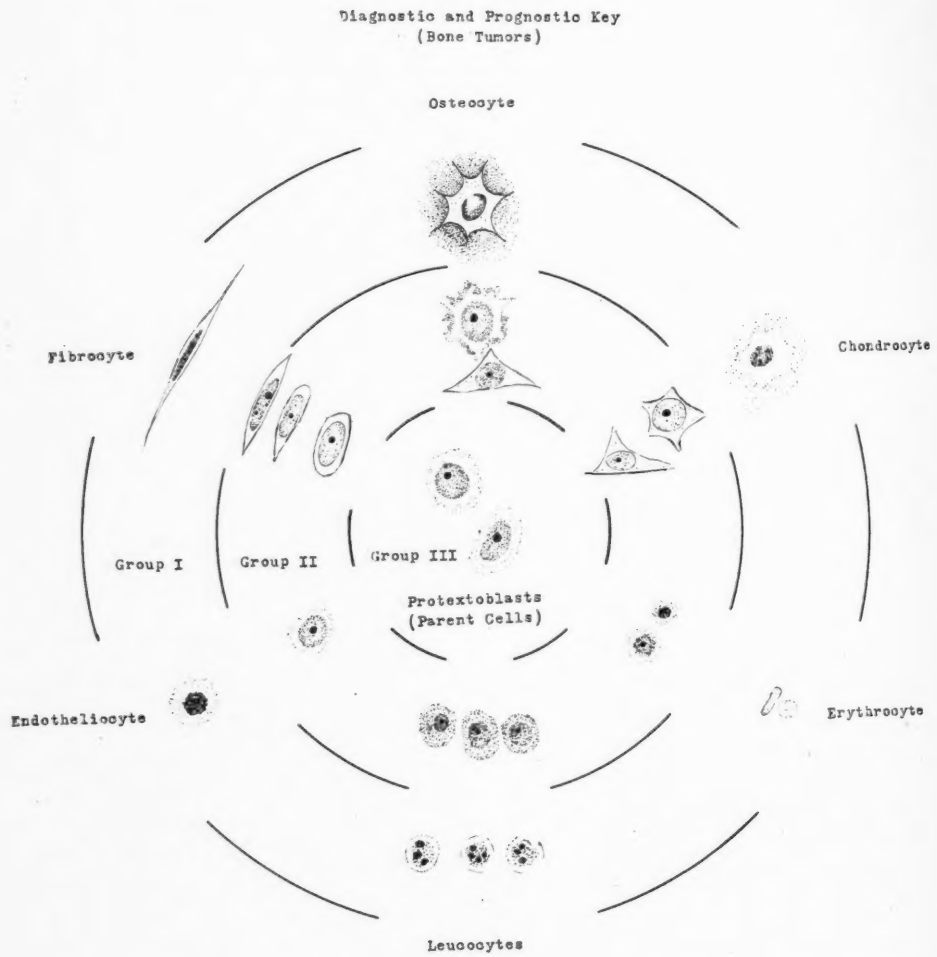

Fig. 1. See text.

that I am personally interested. In doubtful cases, which are numerous enough, the tumor is incised and a specimen removed. This procedure is more conservative than amputation or extensive irradiation without the knowledge of what is being amputated or irradiated. The specimen is examined in a fresh unfixed condition; the arrangement of cells, and the cells themselves, are studied. It will, however, be of little avail to study such specimens unless the pathologist is thoroughly familiar with the characteristics of all types of cells to be found in normal and diseased bones.

In the accompanying diagrams (Figs. 1 and 2) will be found three circular zones: one in the center, one on the periphery, and one intermediate. In the central zone or area are the cells from which all other cells are derived.[2] In the normal evolution of adult cells which are seen in the outer zone one finds under normal and pathologic conditions various structural changes in the intermediate zone. Thus in observing the evolution of osteocytes one finds immature or partially differentiated cells similar to those in the intermediate zone. Such cells are stellate and are surrounded by some or no calcareous material. The nuclei are larger in proportion to the total volume of the cell than is the case in adult osteocytes. The nucleoli are prominent. This description is characteristic of osteocytic tissue in the process of ordinary repair and also under neoplastic regeneration. It may be said, however, that the nucleolus of the immature neoplastic cells is actually much larger in proportion to the volume of the nucleus. There may be more than one nucleolus present in both conditions, but this is certainly more common in neoplastic cells. So far as osteocytic tumors are concerned they may be divided into two recognizable groups: those composed of adult cells, osteocytes, in the outer zone, and those composed of immature cells, osteoblasts, in the intermediate zone. Those composed solely of true osteocytes are benign; the others are definitely malignant. In the absence of leukocytic and lymphocytic infiltration the degree of malignancy depends, in part at least, on the relative numbers of immature cells compared to the adult or mature cells.

Thus in studying fresh unfixed or even good fixed tissues one has only to see with the high power of the microscope the structure of the constituent cells and determine their situation in one of the three zones, the outer being relatively benign and the other two malignant. Any neoplasm composed only of cells of the inner zone cannot be recognized as osteocytic, since there is nothing in the structure of such immature cells to show their relation to any specific adult tissue. In like manner one sees primary neoplasms in bones composed of fibrocytes, chondrocytes, and endotheliocytes (usually in angioid arrangement); the immature cells of each of these are indicated in the different zones leading toward the center.[3]

One never finds in bones neoplasms composed of erythrocytes or leukocytes, but one does find them composed of immature forms such as are seen in the intermediate zone. Thus, by the old terminology for cells, neoplasms are composed of myelocytes (leukoblasts) and nucleated red cells (erythroblasts) and both of these are malignant. The relative positions of cells in the key have been determined by an actual study of more than five hundred neoplasms in bones, malignancy and benignancy being the important consideration and not the names of the tumors or their place in accepted classifications.

Figure 2 shows the results of a study of post-operative length of life of patients suf-

[2]Both a fibroblast and an endothelioblast are placed in the central zone because there is some discussion as to whether all cells arise from a single endothelial or primitive cell or from this type of cell and also from a primitive fibroblast. Be the origin what it may, for all practical purposes both types are found as the simplest and most primitive types of cells in normal and neoplastic bones.

[3]The immature cells of osteocytes and chondrocytes are both stellate, and when there is no deposit of calcium they cannot be differentiated. The clinical significance is, however, the same.

fering from malignant neoplasms of the osteocytic, fibrocytic, and chondrocytic groups; the length of post-operative life is directly proportional to the distance of the component cells from the center of the circles. Tumors belonging to other types of cells in the bone are too few to permit any attempt to determine the average length of post-operative life.

Neoplasms of bone may be classified pathologically as follows: (1) osteo-, fibro-, chondro-, and endothelio-textomas; (2) osteo-, fibro-, chondro-, endothelio-, erythro-, and leuko-textoblastomas, and (3) pro-textoblastomas. The most common neoplasm of bones, in my experience, is a textoblastoma (second group), composed of osteoblastic, fibroblastic and chondroblastic cells in combination.

A type of neoplasm which has been

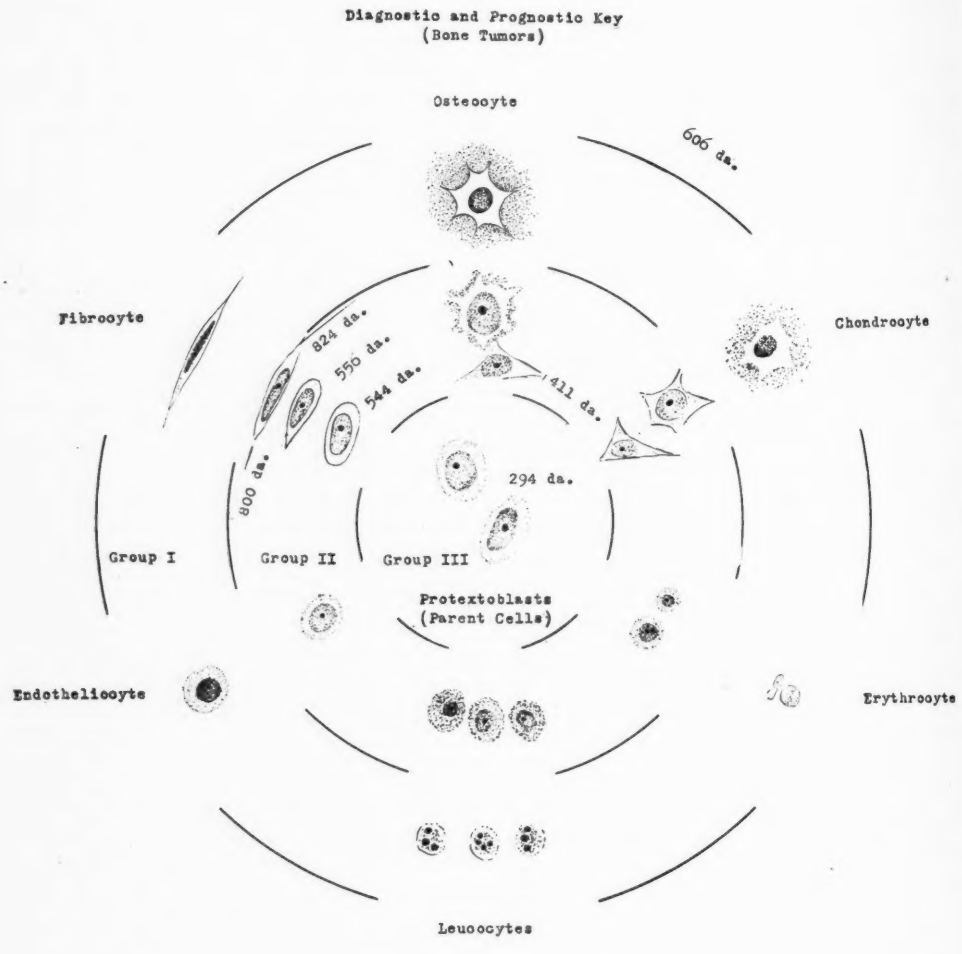

Fig. 2. See text.

widely discussed is the so-called giant-cell tumor. It presents itself usually at the ends of long bones and may or may not be found to be cystic on roentgen-ray examination. The histopathology and cytology are characterized by different pictures. When it is designated giant-cell tumor or sarcoma it contains large and usually numerous giant cells between which may be found connective tissue stroma, with cells of varying degree of differentiation. In most such tumors the cells are usually mature (see outer zone of diagram in Figure 1 for fibrocytes), but in some the cells are not fibrocytes but fibroblasts; were it not for the anatomic situation and the presence of giant cells, they would be called sarcomas. As the stroma of the so-called giant-cell tumor is seen to be more and more cellular the giant cells are fewer and fewer.

Hemorrhagic cysts of the lower end of the femur frequently contain giant cells in their fibrous walls and are probably closely related to the solid giant-cell tumors. By way of speculation it is probable that following injury there is hemorrhage into the bone and surrounding tissues with attempts at organization; giant cells arise under such conditions and the histologic picture, if it is not identical, is readily confused with that of hemorrhagic cystic giant-cell tumor. What probably happens after or during the process of repair is that a keloid, fibroma, or desmoid occurs. We know that some keloids, desmoids, and fibromas show malignant changes. Thus in the uterus fibromyomas are common. They are usually benign; about 1 per cent are malignant. In certain cases of cystic and solid hemorrhagic giant-cell tumors of the ends of long bones it is probable that a somewhat similar history is correct. At least in view of the fact that some giant-cell tumors at the ends of long bones have a post-therapeutic history of malignancy it behooves us not to become dogmatic and say that all giant-cell tumors are benign or that all are malignant. It would be just as incorrect to say that all encapsulated fibro-epithelial tumors of the breast are benign, which is not true, since a small percentage of them are malignant. If such are the facts relative to the so-called giant-cell tumors then a certain difficulty arises in prognosis in all such cases when the diagnosis is made from the site, clinical history, and roentgenograms. I am not prepared to say what kind of treatment should be advised, but I am certain that if the neoplasm were mine I should want a correct diagnosis and radical treatment if the cells of the tumor approached structurally those I have described as being in the intermediate zones of the fibrocytic group. The giant cells, themselves, probably play only a small part in the clinical behavior of the tumor.

CONCLUSIONS

Unless immediate cytologic study is made a clinical procedure, a prognostic diagnosis cannot be made of many neoplasms of bones. With the increasing medical education of laymen, pathologic conditions of bones will be seen by us as smaller lesions, with greater difficulty in diagnosis and prognosis. The diagnosis and prognosis will rest more and more on the properly trained clinical cytologist. His function is one of prognosis, not terminology, and his main object is to render service by accurately informing therapists whether the condition is purely inflammatory, clinically benign, or malignant.

EXOSTOSIS[1]

By HENRY W. MEYERDING, M.D., Section on Orthopedic Surgery, Mayo Clinic, Rochester, Minnesota

FROM properly prepared films the experienced roentgenologist can accurately diagnose those tumors commonly termed exostoses. He is further called on to demonstrate the exact site, size, structure and different single or multiple forms present. Having localized and diagnosed the tumor he is able to observe growth and structural change and thus not only provide the physician with accurate knowledge from time to time concerning the tumor and its relation to the surrounding structures but also reassure the patient.

Exostoses are grouped with the benign osteochondromas, which, depending on the relative content of bone and cartilage, may be classified otherwise as osteoma, chondroma, fibroma, osteochondrofibroma, and osteochondrofibromyxoma, and may be described as pedunculated, compact, cancellous, and so forth. These refinements of classification are not always expected in the roentgen-ray diagnosis; if the roentgenologist will carefully describe the site, size, and apparent structure of the tumor, its relationship to surrounding tissues and whether it is of the single or multiple type, and not attempt too refined a diagnosis, errors will be unlikely.

I have rearranged the classification prepared by the Clinical Pathologic Association and the Sarcoma Registry so that it leads from the inflammatory and benign to the malignant groups:

1. Inflammatory lesions simulating bone tumors (osteoperiostitis).
   Traumatic (callous, ossifying hematoma).
   Syphilitic.
   Infectious (non-suppurative osteitis of Garré, Brodie's abscess, tuberculosis).
2. Osteitis fibrosa cystica; cysts.
3. Benign osteogenic tumors; exostosis, osteoma, chondroma, fibroma (single or multiple).
4. Giant-cell tumors (benign).
5. Angiomas.
6. Endotheliomas (Ewing's tumor).
7. Periosseous fibrosarcomas.
8. Osteogenic sarcomas.
9. Multiple myelomas.
10. Metastatic tumors.

The present series consists of 265 exostoses observed and roentgenographed in 232 patients at the Mayo Clinic who were operated on. The diagnoses were verified pathologically. The average age of the patients was twenty-six and nine-tenths years; the youngest was five years old, the oldest sixty-four. There were 150 males and 82 females. Most of the patients were of the laboring class.

ETIOLOGY

Although heredity is an acknowledged etiologic factor in exostosis, only four of the patients gave or admitted a positive history of this condition in the family. Twelve gave a history of arthritis; other incidental diseases were rare. While rickets and other metabolic disturbances of childhood might be possible etiologic factors, they were not noted. Ninety patients gave a history of trauma (39 per cent); possibly in many instances this was not the cause of the disease but rather of its recognition. In some instances the tumor had been noted for only a few days, while in two cases it had been noted as long as thirty-five years; the average duration was four and a half years. I believe that heredity and metabolic disturbances in childhood are more important factors, and trauma less important than the histories would indicate.

[1]Read before the Radiological Society of North America, at Milwaukee, Wisconsin, November 29 to December 4, 1926.

AGE INCIDENCE

The age incidence of exostosis was very similar to that of sarcoma of the long bones (Table I). Thus, 79.7 per cent of the exostoses and 75 per cent of sarcomas occurred between the ages of eleven and forty.

TABLE I

AGE INCIDENCE

	Exostosis		Sarcoma	
Years	Cases	Per cent	Cases	Per cent
1-10	13	5.6	10	9.1
11-20	71	30.6	34	31.1
21-30	62	26.7	29	26.6
31-40	52	22.4	19	17.4
41-50	21	9.5	11	10.0
51-60	10	4.31	6	5.5
61-70	3	1.25		
Total	232		109	

SYMPTOMS

The typical clinical feature of exostosis is usually painless swelling or deformity; 150 of the 232 patients observed mentioned this; 45 complained of pain. The pain was usually localized and of a dull, steady character, occasionally becoming periodic and sharp. Stiffness of the joints had been noted by eight patients. Twenty-four patients came to the Clinic because they feared the swelling indicated cancer. Five patients came because of recurrence or drainage from previous operations performed elsewhere. The Wassermann test, made in 189 cases, was positive in only two. The urinalysis, carried out in all cases, was of no significance. Joint motion was limited in 60 cases. Slight tenderness on firm pressure was commonly complained of. The skin appeared normal; it was freely movable and without increased local heat, and there was no venous congestion unless there had been irritation from previous treatment. Cytologic examination of the blood repeatedly failed to show any significant changes.

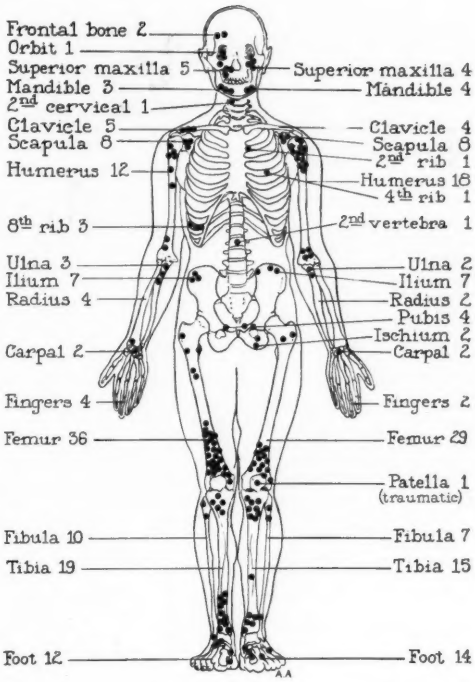

Fig. 1. Sites of exostosis.

CHARACTERISTICS OF EXOSTOSIS

Site.—The exostoses were widely distributed: there were sixty-five in the femur, thirty-four in the tibia, thirty in the humerus, twenty-six in the foot, seventeen in the fibula, sixteen in the scapula, fourteen in the ilium, nine in the superior maxilla, nine in the clavicle, seven in the mandible, six in the radius, six in the finger, five in the rib, five in the ulna, four in the carpus, four in the os pubis, two in the frontal bone, two in a vertebra, two in the ischium, one in the patella, and one in the orbit. The site of each tumor is shown as nearly as possible in Figure 1. The distribution of sarcoma in the long bones is somewhat similar.

Physical signs.—Palpation disclosed firm

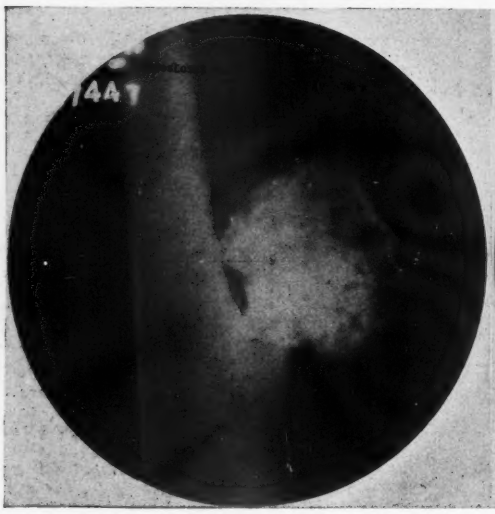

Fig. 2. Exostosis of femur; cauliflower type with narrow pedicle.

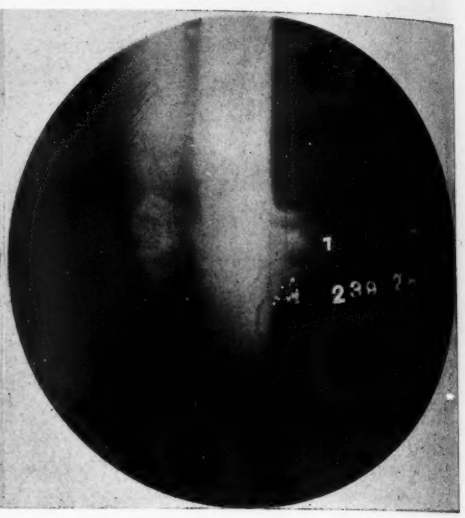

Fig. 3. Exostosis of femur; annular form growing from narrow pedicle.

fixed tumors, sometimes smooth, but at times lobulated by serrations of the cartilaginous cauliflower head. As a result of irritation or infection, the bursa overlying the head may give rise to sudden swelling, and the exostosis may be suspected of malignant change.

Whenever the radiologist had committed himself to a definite diagnosis of exostosis, the opinion was correct. Occasionally the position or the size of the tumor made it difficult to determine its character. Usually the history and the clinical findings established the diagnosis, especially as the duration of the tumors, which averaged four and a half years, would exclude the possibility of malignancy in most instances.

Roentgenographic appearance. — The roentgenographic characteristics of exostosis are: (1) the cortical point of origin is usually in the diaphysis near the epiphyseal line and is most common in the lower end of the femur, and the upper end of the tibia and humerus; (2) the base may vary from a narrow pedicle to a broad one and the tumor from a slight bony projection to a pedunculated mass of varying size; (3) the cortex of the bone may appear continuous with that of the tumor, and often definitely medullary bone is continued into it; (4) while the head may vary greatly in size and shape, yet a cartilaginous cap is common and frequently presents a cauliflower-like appearance; (5) a bursa covers the well-formed tumors, permitting the soft tissues to be moved without great pain, as well as protecting the skin from irritation by the mass; if the tumor is traumatized (and hemorrhage is produced within) or infected, the swelling may sometimes be observed in the radiograph; (6) exostoses occur both as local and general tumors and may present numerous deformities; (7) there is no invasion but rather penetration of tissue; (8) bone is not absorbed except as the tumor causes pressure on neighboring bony structures; (9) the periosteum is expanded over the tumor, but otherwise presents no abnormality, and (10) growth is usually away from the joint.

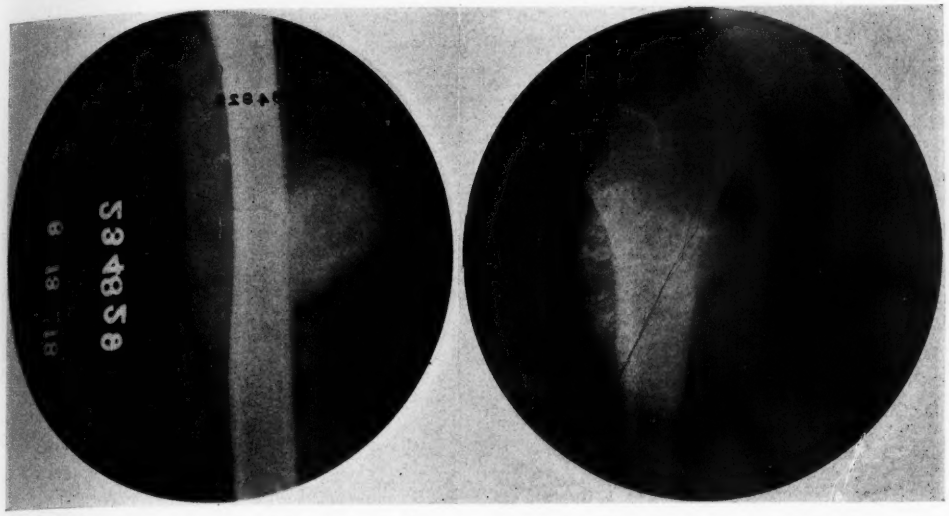

Fig. 4. Exostosis of femur which had been diagnosed sarcoma.

Fig. 5. Exostosis of femur; cauliflower type arising from narrow pedicle behind lesser trochanter. The direction of the rays, simulating sarcoma, is due to the position.

TREATMENT

The treatment of these osteocartilaginous tumors is surgical; however, their presence is not always an indication for operation. In this series many of the tumors had existed from ten to thirty-five years without apparent menace to the patient, yet I believe that a well-formed tumor which is causing deformity, inconvenience or pain, should be removed. The roentgen ray is the surgeon's greatest aid and, with the earlier diagnosis and differentiation of tumors made possible by its use, many needless exploratory and mutilating surgical procedures will be avoided. Usually excision with snug layer suture of tissue to prevent hematoma is sufficient; however, cautery or post-operative radiotherapy may be used when recurrence is feared. The bursa must always be excised because hemorrhage into the sac and ossification may reproduce the tumor; likewise, all cartilage must be excised. I prefer complete excision of the bursa, capsule, cartilage and bone intact, with cautery to the exposed bone, and close layer suture. If hematoma appears inevitable, I insert a small rubber-tissue drain for forty-eight hours. In this series of cases excision alone was performed in 61 per cent, and excision and cauterization in 38 per cent.

PROGNOSIS

The prognosis is good in the single types when the tumor may be removed without too much damage to the periosseous structures or to the joints. Multiple exostoses may cause marked disability, deformity and pain on movement. Surgical removal of many of these tumors, when indicated, may lead to improved function and freedom from pain.

In this series, recurrence was noted in 10 per cent. About 75 per cent of the patients were heard from after being dismissed from observation and 83.8 per cent of them reported that they had been cured.

Five deaths from one to nine years after operation were reported; there was no surgical mortality.

Fig. 6. Exostosis of upper humerus. By rotation at right angles the same effect was produced as in Figure 5.

ABSTRACTS OF ILLUSTRATIVE CASES

Case 1.—A farmer, aged twenty-three, came to the Mayo Clinic because of a tumor of the right femur, of thirteen years' duration. The family history was negative. There was no pain or tenderness, and no history of trauma. The tumor was attached to the diaphysis, and was slowly increasing in size.

The roentgenologic diagnosis was cauliflower exostosis (Fig. 2). There was no impairment of joint function; the Wassermann test and urinalysis were negative and the blood count normal. The patient wished to have the tumor removed as it was causing noticeable deformity, and in April, 1919, it was chiselled free at the base, and the actual cautery applied.

The patient is well at this time, and there has been no recurrence.

Case 2.—A laborer, aged thirty-two, complained of pain in the knee and leg, which began following trauma three years before examination. A tumor had been noticed in the middle third of the left femur; it was firm, fixed, smooth, single and slowly enlarging. There was no impairment of the joint, but there was some local tenderness, with swelling and dull pain. The urinalysis and Wassermann test were negative and the blood normal.

The roentgenologic and clinical diagnosis was exostosis. July 23, 1918, the tumor was excised and found to be an exostosis arising from the shaft of the femur and encircling about three-fourths of the femur in

a bracelet-like manner so that the tumor had to be split to be removed (Fig. 3).

Case 3.—A housewife, aged thirty-nine, had complained of a tumor of the right humerus for one year. It came to her notice accidentally because of a dull pain. There had been slight tenderness on pressure, and gradually increasing swelling. The tumor was firm, fixed, smooth on palpation and apparently single (Fig. 4). There was no history of a similar condition in any other member of the family. The patient had been told elsewhere that this tumor was a sarcoma, and roentgenograms had been taken.

There was no joint impairment; the Wassermann test and urinalysis were negative and the blood count normal. At operation in June, 1918, an exostosis was removed from the middle third of the right humerus on the inner side. It was closely associated with the musculospiral nerve and with the vessels. Following excision, the base was cauterized. The pathologic report was osteofibroma.

The patient was heard from in 1926, at which time she was in good health.

Comment.—The diagnosis in this case was established by careful study of the roentgenogram, corroborated by microscopic examinations, which were not considered characteristic of sarcoma.

Case 4.—A plumber, aged twenty-five, accidentally noticed a swelling about the hip, three days before examination. The mass, which appeared to be about 9 cm. in diameter, was firm, fixed, smooth, and single and apparently involved the upper third of the femur. There was no pain or limitation of joint motion; the urinalysis and Wassermann test were negative and the blood cytologically normal.

The roentgenologic diagnosis was osteochondroma involving the lesser trochanter of the femur (Fig. 5). In June, 1921, the tumor was found to be attached just posteriorly to the lesser trochanter and was excised. It was encapsulated, with a well-formed bursa and a layer of cartilage 0.6 cm. thick, which covered the entire head. The patient convalesced uneventfully and a good result was obtained.

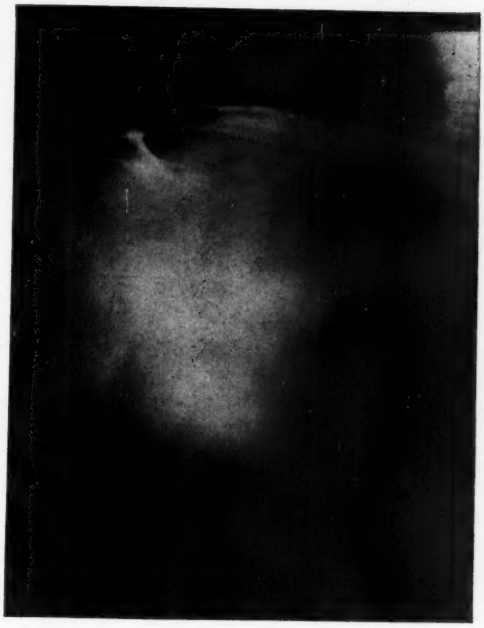

Fig. 7. Exostosis of scapula of three years' duration.

Case 5.—A girl, aged fourteen, a student, complained of a growth in the left shoulder, which had been present for eighteen months and had been diagnosed elsewhere as sarcoma. While there was no family history of similar trouble, there was a history of fracture. The tumor appeared firm, fixed, smooth and, although it had gradually increased in size, had produced no stiffness in the joint, or pain. The Wassermann test and urinalysis were negative and the blood cytologically normal.

The roentgenologic diagnosis was osteochondroma (Fig. 6). October 13, 1924, an osteochondroma, 12 or 15 cm. in length,

was chiselled free from the upper humerus. The base was cauterized following excision and roentgen-ray treatment was given after operation; the result was good.

Case 6.—A merchant, aged forty-two, had complained of a tumor of the right shoulder for three years. The tumor was firm, fixed, single, slow-growing and involved the right scapula. There was no pain or limitation of joint motion; the Wassermann reaction and urinalysis were negative and the blood count normal.

The roentgenologic report was extensive destruction of the scapula, probably chondroma, with malignant change (Fig. 7). In June, 1921, the tumor, together with three-fourths of the scapula, was excised, the portion of the scapula in the region of the shoulder joint being left intact. The tumor had pushed its way into the axilla, but, in spite of its large size, permitted good movement. The result was good.

Comment.—Tumors of this size so obscure the roentgenographic appearance that it is difficult to determine their exact nature. In this case the three-year history and the clinical findings were of assistance in arriving at the proper diagnosis.

DIAGNOSIS AND TREATMENT OF BONE LESIONS OF THE HAND AND FOOT, WITH SPECIAL REFERENCE TO BONE TUMORS[1]

By MAX KAHN, M.D., and L. CLARENCE COHN, M.D., BALTIMORE, MD.

WE are frequently confronted with a roentgenogram of a hand or foot which reveals a more or less definite bone lesion and it is our desire here to present a method of diagnosis based upon a review of our experience with these lesions up to the present time. This study has been made from the histories, roentgenograms and gross and microscopic specimens of 89 cases involving the bones of the hands and feet, out of a total of over eleven hundred bone lesions recorded in the Surgical Pathological Laboratory of Johns Hopkins Hospital up to June, 1926.

It is interesting to note that of these 89 cases, 60 have come under observation since 1920. Previous to 1920 there were only 29 cases and of these, three cases were recorded up to 1910, so that about two-thirds of the cases have come under observation in the last six years. We can see, therefore, that patients with these lesions are consulting physicians earlier now than previously and we feel that this is largely due to the pioneer work of Dr. Bloodgood in educating the public.

The majority of these lesions came under observation at an age when trauma is most likely to occur. Of 66 cases in which the age has been recorded, 42 occurred before the age of thirty and there were almost twice as many males as females. Nearly one-half of the lesions involved the tarsal bones. Of the remainder, almost one-half involved the phalanges of the hands and feet and the other half involved the metacarpals and metatarsals. The remaining lesions comprised three multiple lesions of the hand, three multiple lesions of the foot, and one multiple lesion involving both the hand and foot.

Of the 89 cases, we have the pathological diagnosis in 65, based on clinical signs, laboratory findings and X-ray evidence in 24 cases. The cases fall into the following groups: exostosis, 28; chondroma, 11; giant-cell tumor, 8; myxoma, 6; osteitis fibrosa, 4; sarcoma, 2. The remaining 6 cases comprised: osteomyelitis, 2; epithelial lined cyst, 2; hemangioma, 1, and ossifying hematoma, 1. One can see readily from these figures that the largest group consisted of exostosis, or osteoma. This tumor rarely gives trouble in diagnosis and can be easily recognized by the most inexpert. The last group mentioned, consisting of osteomyelitis, epithelial lined cyst, hemangioma and ossifying hematoma, has as yet no positive clinical picture—no characteristic X-ray appearance, with the exception of osteomyelitis. Osteomyelitis involving the metacarpals, metatarsals and phalanges is not clinically and roentgenologically unlike that found in bones elsewhere in the body, and should be recognized. Osteomyelitis involving the carpals and tarsals is difficult to recognize. Deducting, therefore, the 28 cases of exostosis, the 4 unusual lesions and the 2 cases of osteomyelitis, we have left 31 cases for diagnostic consideration. There are only two cases of sarcoma, a chondrosarcoma of the astragalus and a small round-cell sarcoma of the os calcis in which there was a question as to origin in nerve sheath or fascia with secondary involvement of bone. It is well here to point this out and to emphasize that this conforms with experience and is an established fact, namely, that sarcoma rarely involves the bones below the wrist and below the ankle. Of the 31 cases, 11 were chondromas, 8 giant-

[1]Read before the Radiological Society of North America, at Milwaukee, Nov. 29–Dec. 4, 1926.

cell tumors, 6 myxomas, 4 osteitis fibrosa, and the 2 cases of sarcoma just mentioned. It will be seen, therefore, that, leaving out the exostosis, the most common tumor of the hand or foot is a chondroma, the next most frequent the giant-cell tumor, then the myxoma, next the osteitis fibrosa or bone cyst, and the rarest sarcoma.

The problem from the X-ray standpoint, therefore, is the differential diagnosis between chondroma, myxoma, giant-cell tumor and osteitis fibrosa. There is no characteristic X-ray appearance of any one of these tumors, so that roentgenologically it is practically impossible to make a positive diagnosis. There is more or less bone expansion in all, they are all central tumors and the thinning, absorption and bone destruction are more or less similar in appearance.

The myxoma requires special treatment and the surgeon must be prepared to recognize it at operation. All of the patients with myxoma up to the present time in whose cases the growth was cut into with the knife at the first operation are dead from the disease, after local recurrence and metastases. As the myxoma is the most transplantable of all tumor tissue the cautery must be ready in all operations on bone tumors, because, if myxoma is encountered, that gives the patient his only chance for cure. X-ray treatment of myxoma is practically without value. Myxoma appears to be especially resistant to radiation and is not influenced by this form of treatment. Curettement, followed by thermal and chemical cauterization, has been the method of choice in the treatment of bone tumors of the hands and feet, and when a metacarpal is involved it is sometimes preferable to resect the entire bone with the cautery, giving the tumor a wide margin and later transplanting bone. The results of X-ray treatment in giant-cell tumor involving bones other than those of the hands and feet, where the diagnosis could be made with a certain degree of accuracy, have been excellent in some reported cases.

In summarizing, it is well to point out, first, that sarcoma of bone is rare below the wrist joint and below the ankle joint; second, the most common tumor is exostosis and the next in frequency of occurrence is the chondroma; third, myxoma in this study is found to be comparatively more frequent in the bones of the hands and feet than in other bones.

DISCUSSION

DR. J. C. BLOODGOOD (Baltimore): I thank you for this opportunity to discuss this group of papers which present splendidly our knowledge up to date of bone tumors. I doubt if I can say anything new, but I would like to emphasize a viewpoint that has impressed me more than any other in the last five years. We are beginning to reach a point in the differential diagnosis of bone lesions where our responsibility is greater than it ever was before. The majority of you, in your experiences, do not go back as far as I do, but in my first ten years—up to 1900, when I lived in a hospital perhaps as far advanced as any other hospital in this country—I do not remember any difficulty with diagnosis, yet to-day, since 1920, when we have instruments of precision that we did not have before 1900, when we have accumulated experience which we did not have before 1900, we have more difficulty in diagnosis than we had in those early years, and these difficulties are due to the fact that we are now living in a more educated community. We are seeing every disease in its incipiency, and in spite of our greater knowledge and in spite of the wonderful instruments of precision, we find that we are not always prepared to recognize the disease and to select the best treatment. Now the responsibility involved in bone lesions is a very great one, if we feel that for malignant disease amputation or re-

section offers the best opportunity of a cure. If we do not feel that amputation or resection offers the best opportunity of a cure, then we can try radiation; it will do no harm for benign cases and may accomplish a cure in malignant cases. My evidence up to date indicates that when the malignant bone lesion is below the middle third of the femur, or is situated in the upper extremity, if it is in such an early stage that it can be resected, operation offers a larger percentage of cures than radiation. Therefore it is essential to make a differential diagnosis, because the vast number of bone lesions to-day are not malignant, and unless you can make that differential diagnosis, you will mutilate for a benign tumor. There are some cases in which the X-ray is the instrument of precision that tells you what the bone lesion is. In many cases you can amputate or resect on the X-ray examination alone; in other cases you cannot. Therefore, if you feel that operation is the indicated procedure, there must be another method of diagnosis. At the present time we have a method older than the X-ray—the pathological examination of a piece excised and studied under the microscope. This is by no means a new procedure. The pathological study of tumor tissue dates back many years; frozen sections go back to the nineties; I made frozen sections in 1893. The difficulty is that at the present time, in the majority of clinics of this country, we have splendid X-ray conditions and we get good plates; we have experienced and trained men who can diagnose from X-ray plates, but, in spite of the fact that pathologists were here first and trained first, our operating rooms are not provided with trained pathologists who can interpret frozen sections. It is a very important thing for the great hospitals of this country to realize the importance of the study of tissue in the operating room and to provide for it as they have provided for X-ray departments. It is always a great pleasure for me, whenever I have an opportunity, to give credit to the importance of tissue diagnosis in the operating room to Dr. Wilson and Dr. MacCarty, of the Mayo Clinic; they have been advocating it for years. The possibilities are that this provision in small operating rooms has not taken place because of the difficulties of technic of making a frozen section. It is more of a technical problem to make a good frozen section than it is to make a good X-ray plate, and in spite of my profound respect and admiration for the roentgenological diagnosis, I really believe it is more difficult to train a tissue pathologist for diagnosis than it is a roentgenologist. One remarkable fact is that while the development of roentgenology in the hospitals has been a financial success, the development of pathological diagnosis has been a financial failure. I have not time to discuss it, but I really believe the great thing for us to come together about to-day is biopsy—how it should be done. Prepare for the diagnosis of those cases that cannot be diagnosed by the X-ray—prepare for their diagnosis by biopsy.

TREATMENT OF NEVI WITH RADIUM[1]

By ZOE ALLISON JOHNSTON, M.D., PITTSBURGH, PA.

OF nevi, or birthmarks, those anomalous developments of certain tissues of the skin and subcutaneous structures, there are two main varieties to be considered in connection with radium treatment—the pigmented and the vascular. The pigmented are characterized not only by increased deposit of pigment, but at times by hypertrophy of other cutaneous structures. Vascular nevi, of course, are those characterized by an overgrowth of vascular tissue. Both types of lesions—as is well known—are congenital, and appear at birth or shortly thereafter. A large percentage of them develop on the face and neck, so that the treatment becomes not simply a question of removing an objectionable overgrowth of tissue, but one of very careful treatment to obtain the best cosmetic effect.

There is a large classification of pigmented nevi, and the treatment depends upon a number of factors, such as position, size—both as to elevation and surface involvement—presence or absence of hair, fatty consistency, or very deep pigmentation with a tendency toward malignant changes.

Small, faintly pigmented nevi are probably best removed by desiccation. When the surface involvement is great, radium must be considered, or at least radium combined with desiccation, because there is less scarring following judicious radium treatment. Hairs must be removed by the electric needle previous to removing the nevus by some other method, but if radium is used, beta radiation will cause epilation. All deeply pigmented moles showing a tendency towards overgrowth or inflammatory irritation should have sufficient dosage of beta radiation to destroy absolutely the tissue involved. This will prevent the malignant development of the pigmented mole.

If I may be permitted to repeat a familiar classification, there are three types of vascular nevi:

1. Nevus flammeus, or port wine mark. This is flat, non-elevated, and consists of a network of dilated capillaries.

2. Nevus vasculosus, or elevated angioma, consisting of a network of large dilated blood vessels.

3. Angioma cavernosum, consisting of enormously dilated blood vessels, which destroy the surrounding tissues by mechanical interference.

There are, besides, a number of elaborate classifications, but this one by McKee, from the standpoint of treatment, is concise and covers the subject.

Port wine marks vary greatly in size, from very small lesions to extensive ones involving an entire limb, the chest, or half or more of the face. They are usually of a brilliant red or purplish red hue, this, of course, varying according to the vascularity of the mark. The edge is usually irregular. There is no question but that port wine marks are the most difficult to treat with satisfactory results. To produce an even fading of the color is almost an impossibility. There is great variation of opinion as to the best method to pursue, but excellent results are reported from the use of the Kromayer modification of the Cooper-Hewitt mercury vapor generator, a method which requires frequent treatments over a long period of time.

In the past radium has been used quite extensively, though some authors condemn its use. From the reports of the latter one would judge that the dosage employed by them was enough to produce destruction of the tissues. This is a mistake, as permanent injury to the skin may result. Smaller doses will shrink the vessels without destroying the other tissues, if the lesion is one

[1]Read before the Roentgen Ray Society of Central Pennsylvania, Oct. 29, 1926.

which will respond to radium at all. This treatment must be given slowly, the applications being at least two months apart. The ideal way to make a radium application to a port wine mark is to treat the entire mark at one sitting. If the lesion is large this is impossible, and it is better in that case to treat it by dividing it in sections. No class of cases requires a more skillful technic, but with caution and persistence good results can be obtained.

Fig. 1. Case I, before treatment.[2]

Fig. 2. Case I, after treatment.

Vascular nevi involve only the superficial vessels, and, as we have noted, are elevated above the skin. They are very common and occur usually around the face, although any part of the body may be the site of one of these lesions. This type responds readily to radium. The radiosensibility of blood vessels is well known, the endothelial lining of the vessels being so sensitive that a small dose will produce obliteration of the lumen. The construction of an overgrowth of tissue of this type is ideal for radium treatment. One or two applications will cause the disappearance of the small lesions which are so frequently found on infants. Larger lesions, of course, require more treatment, extending over a longer period of time, according to the size and position of the lesion. If it is definitely elevated above the skin surface, radium needles can be inserted to great advantage. One treatment by this method will take the place of a number of surface applications, and, of course, shortens the treatment time considerably.

The technic of application of the radium naturally varies according to the type, size, and location of the lesion. Each individual case must be studied and the treatment planned to give efficient radiation to all parts of the abnormal tissue without affecting the normal surrounding tissue. If the mark is a small, slightly elevated angioma, a super-

[2]This illustration is used by permission of *Urologic and Cutaneous Review* (see that journal, Jan., 1927, p. 35) and by special arrangement with the author of that paper.

ficial application of radium, mainly beta rays, is used. If there is marked elevation, radium needles can be inserted through the mark at regular intervals. Wherever possible insertion of radium is the method of choice. This is especially true if there is normal or almost normal skin overlying an angioma. If insertion of radium does not seem desirable and the angioma has considerable depth, the radium is filtered. This filter varies, although we usually use one millimeter of brass and one millimeter of rubber. The distance at which the radium is placed from the patient varies according to the depth of the lesion.

Fig. 3. Case II, before treatment.

Fig. 4. Case II, after treatment.

Angioma cavernosum is a soft spongy tumor consisting of enormously dilated vessels. The skin may be normal or nearly normal over one of these soft masses of tumor tissue, or an angioma vasculosus may involve the skin over an angioma cavernosum. The last mentioned combination seems to be the most common type met with. Palpation of these angiomata reveals a soft spongy condition which is very characteristic. They also respond to radium treatment in a manner far superior to any other method. If not too deep, beta radium radiation is indicated. If they are extensive, gamma radium rays, or radium buried into the mass, is the method used. Cavernous angiomata, with a normal or fairly normal skin surface, are ideal for embedded radium. The radium needles must be inserted carefully in order to distribute the radiation equally to all parts of the mass.

Many persons inquire about the spontaneous disappearance of birthmarks. Disappearances are reported, but usually these cases have a faint, even, red mark hardly noticeable when the child is sleeping, but becoming quite red and angry when the child cries. I have not read any reports of well developed nevi disappearing. They usually enlarge with the growth of the child and sometimes the enlargement is

rapid and entirely out of proportion to the growth of the body. It seems unwise to postpone treatment expecting a disappearance of the mark.

The age at which children should be treated is often inquired about. Many doctors and parents are in doubt as to the best time to start treatment. It seems that, since there are bound to be very definite changes in the tissues in a majority of cases, the earlier treatment is instigated the better chance the tissues have of assuming normal condition during the natural course of development following the treatment. Babies with birthmarks should be treated as soon as it is safe to take them out of the house.

When radium is used in the treatment of any type of birthmark, especially the very extensive, it should be fully agreed upon before the treatment is started as to the length of time it may be expected to take and also as to the intervals between treatments. Two to three months should intervene between radium applications. This gives plenty of time for slow tissue changes to occur and also allows time for color changes. The entire time of treatment, of course, depends upon the extent of the lesion. Many lesions require treatment over a period of from one to two years.

Fig. 5. Case III, before treatment.

Fig. 6. Case III, after treatment.

Other methods of treatment used.—Surgery, desiccation, electrocoagulation, and carbon dioxide snow are the most common, and some splendid results are reported. Sur-

gical removal is often considered, but the possibility of recurrence is great, and, on the whole, the danger of scarring is greater than it is following radium treatment. Freezing with carbon dioxide snow has been

It is interesting to note in looking over the literature the methods used by the various writers. Simpson reports good results in the treatment of port wine marks by the use of flexible radium "toiles," which are

Fig. 7. Case IV, before treatment.

Fig. 8. Case IV, after treatment.

very popular. However, it is painful and is more likely to leave scars which are thick and almost keloidal in character. Desiccation and electrocoagulation are valuable in certain types of nevi, and may be used alone or in conjunction with radium.

The disadvantages of radium are that the treatment is slow, the economic features are to be considered, and there is the danger of telangiectasis appearing in the future. The advantages of radium are that it is easy of application, is painless, never requires an anesthetic, produces no marked reaction, has no effect on surrounding healthy tissue, and leaves a minimum of scarring with no contracture of the skin. This method is advocated because treatment of a large number of cases has been uniformly successful.

cloths impregnated with radium. Their use gives an even distribution of the radium to the lesion. He is very enthusiastic concerning the use of radium in all vascular nevi.

John McHutchinson and Herbert Brown report five cases of nevi of the vascular type treated by radium with splendid results. Two of these were port wine marks.

Morrow and Taussig do not report very good results in the treatment of port wine marks with radium, but advise the water-cooled mercury lamp. In vascular nevi their results are better with radium than by any other method.

McLean and Cannon advise the use of the Kromayer lamp and desiccation in the port wine marks, and state that X-ray, radium, and carbon dioxide snow are of little or no

Fig. 9. Case V, lateral view, before treatment.

Fig. 10. Case V, antero-posterior view, before treatment.

Fig. 11. Case V, lateral view, after treatment.

Fig. 12. Case V, antero-posterior view, after treatment.

value. Their experience with carbon dioxide snow has given splendid results in circumscribed discrete angioma, but radium has been used successfully.

McKee reports good results with radium in vascular angioma, with poor results in the treatment of port wine marks.

Birthmarks seem like trivial matters in

the list of diseases and conditions that can be treated by radium, but they must not be considered as such. Each case demands the earnest consideration of the physician in charge. To the parents or the patient this condition is of the greatest importance. It is not a matter of life or death, but unsightly marks or scars can be the source of much embarrassment. Treatment undertaken lightly, resulting possibly in more scarring than is necessary, will be a life-long reminder to the physician that his experience or training was not sufficient for this work. Experience must be the guide in the choice and use of a therapeutic agent. I am convinced that the most thorough removal and the best cosmetic result can be obtained in the treatment of nevi by the use of radium.

CASE REPORTS

Case I. Referred January, 1925, with birthmark involving inner half of left upper eyelid. It was present when the child was born and was increasing in size. The birthmark pushed the eyelid down over the eyeball, interfering with the sight.

Two needles, each containing ten milligrams of radium, were inserted for one hour and fifteen minutes. That was the only treatment necessary.

Case II. Angioma of the upper lip noticed at birth. Grew gradually, involving two-thirds of the upper lip and extending up into the left nostril. Surgical removal in May, 1921, at the age of three months. Referred for treatment November, 1921, at the age of nine months. At this time there was a scar extending from the left nostril to the lip. On both sides of the scar there was red discoloration with extensive involvement underneath. Almost the entire upper lip was involved. It felt spongy when palpated and was twice as thick as a normal lip.

Six applications of radium were given from November, 1921, until June, 1924. The first treatments were heavily filtered, using one millimeter of brass and one millimeter of rubber, followed by more superficial applications, using only one millimeter of rubber for filter.

Case III. Referred March, 1922, with angioma involving the entire nose with the exception of a small part of the right side. Also one on the right shoulder extending well onto the right chest wall, which measured 3 by 3½ inches and was elevated from one-fourth to one-half inch above the skin surface.

A number of small applications were given over selected areas from March, 1922, until completion of the treatment in September, 1924. I will mention only the needles that were inserted: March, 1922, three needles, each containing ten milligrams of radium, were inserted through the nose for forty-five minutes; August, 1922, eight 10-milligram needles were inserted through the lesion on the shoulder for one hour and thirty minutes. In June, 1923, one part of the nose still remained spongy, and one 10-milligram needle was inserted for one hour.

Case IV. Referred July, 1923, for removal of a hairy pigmented mark which had been present since birth. On account of the color of the mark the hairs were not very noticeable. Not being vascular, some scarring is to be expected.

An application of radium, using beta radiation in sufficient dosage to cause a marked reaction, was given. This was repeated in about two months. The mark became smaller and flatter and all of the hairs were removed. The remainder was removed by using the electric spark on the brownish areas, gradually covering the entire surface.

Case V. Referred January, 1923, with a very deforming angioma involving the tissues of the upper part of the nose, and areas both above and below the inner half

of the left eye, with several small areas on the forehead. Almost the entire lesion was a deep purple, with the exception of a portion at the lower edge and about the same at the upper edge, which areas were covered with normal skin.

Nine applications of radium were given from January 1, 1923, until December, 1926. To treat the deeper portions two 25-milligram tubes, filtered by one millimeter of brass and one millimeter of rubber, were used at a distance of two centimeters. Around the edges and the parts that were not so thick the radium was filtered only by the silver radium container and one millimeter of rubber. The scar is soft and pliable. A few telangiectatic lines show up in the center of the area. When the child is a little older these will be removed by the electric needle.

THE SIZE OF THE HEART IN THE NORMAL AND IN ORGANIC HEART DISEASE[1]

By J. A. E. EYSTER, M.D., Department of Physiology, University of Wisconsin, MADISON

CARDIAC roentgenography has two practical aspects, inspection under the fluoroscope and mensuration of the silhouette outlines. The former is mainly concerned with an examination of the great vessels, especially the aorta, although here also mensuration may be applied (1). The present communication is confined to a study of certain measurements of the cardiac silhouette and deals with a comparison of clinically normal hearts and those with organic disease.

METHODS

Two general methods exist for obtaining an outline of the orthographic projection of the cardiac shadow, teleoroentgenography and orthodiagraphy. In the former a photographic record is obtained, in the latter a pencil outline of the shadow is made. P. C. Hodges (2) has shown that the two methods yield, as would be expected, the same result when the same general technic is used. The advantages of the teleoroentgenographic method are the obtaining of a shadow free from possible subjective errors and the ease with which the record may be obtained by a routine technician. The orthodiagraphic tracing has numerous advantages which, in my opinion, make it the preferable method. It is done at the same sitting with a general fluoroscopic observation; it is practicable in the lateral and oblique views as well as the frontal, and it makes possible a more complete outline of the cardiac silhouette, especially in the frontal plane. In man the heart usually lies quite low, its lower border resting on the diaphragm, and it is difficult or impossible in most cases to differentiate between the shadow cast by the lower border of the heart and the diaphragm. Under the fluoroscope, in spite of the fact that these two structures cast about the same density of shadow, the fact that one is in continual motion makes possible a greater degree of completion of the lower contour of the heart shadow, leading to more accurate mensuration.

Mensuration of the cardiac shadow has been confined, so far as I know, to the frontal plane contour. The types of measurements that have been made are numerous, but two have proven of especial value,—the greatest transverse diameter of the shadow and the enclosed area. That there is a relationship between the area of the cardiac frontal plane silhouette and the volume of the heart has been shown by Bardeen (3) in man and by Skavlem (4) in the dog.

MENSURATION OF THE NORMAL HEART

A number of workers have attempted to establish standards of measurement for the heart of normal subjects (5). It has been found that the size of the heart in the normal subject depends, in part, at least, upon three factors—height or stature, weight, and age—and attempts have been made to develop a prediction formula based on these factors. The most recent of these by P. C. Hodges and Eyster (6) and by F. J. Hodges and Eyster (7), differ from preceding ones in two particulars: first, that the subjects were carefully selected after a thorough clinical examination, and, second, that the data were treated mathematically by statistical analysis in the construction of the prediction formula.

It is obvious that the construction of a prediction formula for cardiac silhouette area and transverse diameter is of little value clinically unless one can show that the

[1]Presented before the Radiological Society of North America, at Milwaukee, Nov. 29–Dec. 4, 1926.

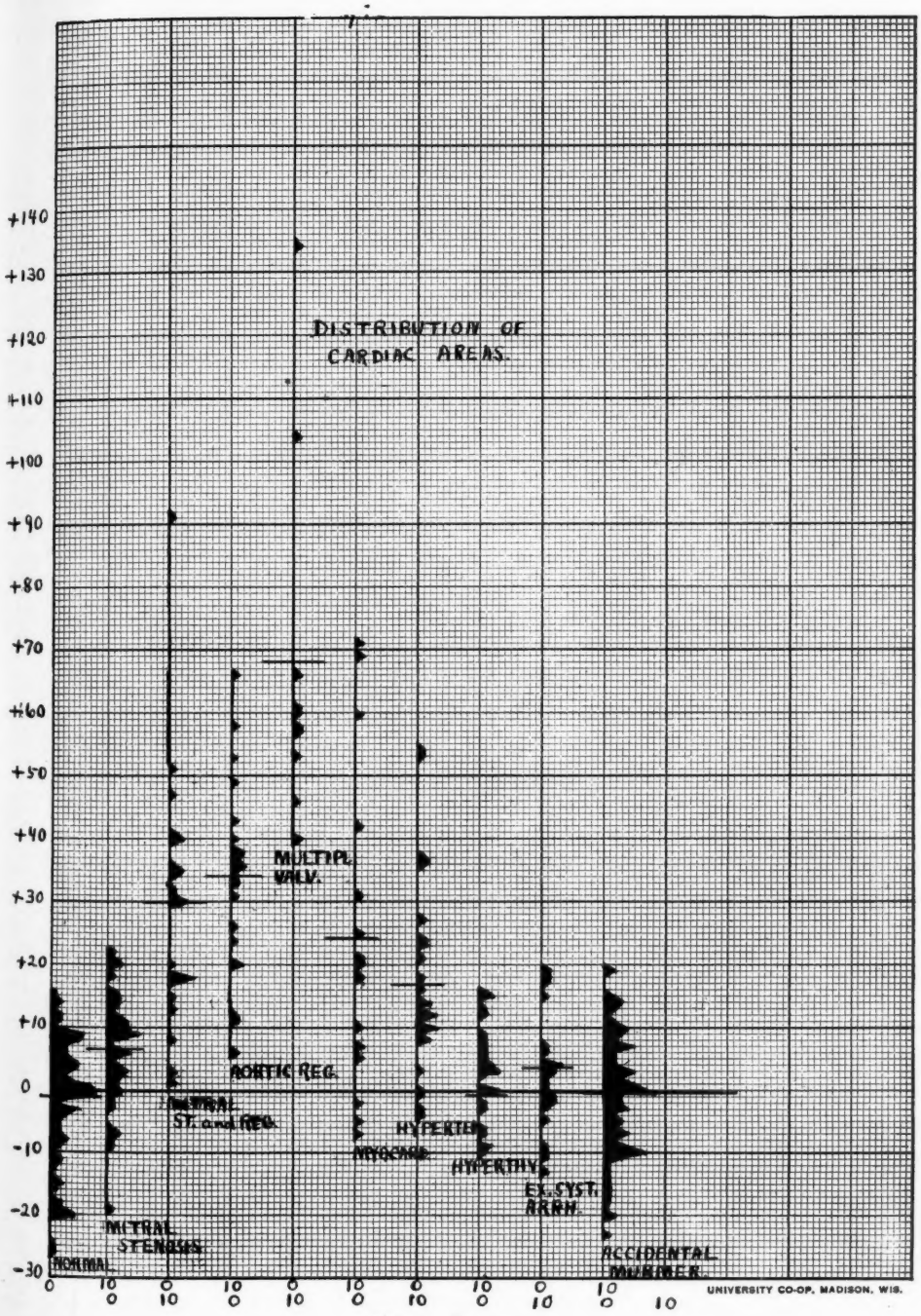

Fig. 1. See text.

TABLE I

PERCENTAGE DISTRIBUTION OF CARDIAC SILHOUETTE AREAS

Group	No. of cases	−30 −25	−24 −20	−19 −15	−14 −10	−9 −5	−4 −0	+1 +5	+6 +10	+11 +15	+16 +20	+21 +25	+26 +30	+31 +35	+36 +40	+41 +45	+46 +50	+51 +55	+56 +60	+61 +65	+66 +70	+ 70 +100
Normal	100	1	4	6	5	10	24	23	16	8	1											
Mitral stenosis	50			2		10	10	18	28	20	8	4										
Mitral stenosis and mitral regurgitation	25							8	4	8	20		12	20	8	4	4	4				4
Aortic regurgitation	25								4	8	8	4	8	16	28	8	4	4	4		4	
Multiple valvulitis	10														10		10	10	30	10	10	20
Myocarditis	15				12	7			20		13	13		7		7		7			7	7
Arterial hypertension	25						16	4	20	20	8	12	4		8			8				
Hyperthyroidism	25		4		12	32	12	12	8	16	4											
Extra-systolic arhythmia	24				12	8	25	29	8		18											
Accidental systolic murmurs	100		1	4	12	13	24	14	21	7	3	2										

range in cardiac disease is reasonably different from the normal range. The essential question presents itself as to whether or not cardiac enlargement can be determined by X-ray methods with sufficient accuracy to make the method of clinical value.

The distribution of cardiac silhouette areas in a hundred normal male subjects in relation to the predicted area, as determined by P. C. Hodges and Eyster, is given in the first column of Table I and charted in the first curve of Figure 1. These subjects were different from those on whom the original prediction formula and table were based, but were also carefully selected after a complete physical, fluoroscopic and electrocardiographic study. In all cases they are tabulated on the basis of plus or minus percentage variation from the predicted area. In the table, the percentage of the totals falling in groups of 5 per cent variations from the prediction are given. In the chart (Fig. 1) the ordinates represent plus or minus percentage variations from the prediction, the abscissæ the number of cases at the various levels of variation. The arithmetical average of the whole group is expressed by the short horizontal line intersecting the group. It will be seen that the average for the whole group is —1.0 per cent as referred to the predicted area. The range is between —27 per cent and +16 per cent. Nine per cent of the 100 cases exceed 10 per cent above the predicted area and 1 per cent exceeds 15 per cent. The transverse diameters averaged +1.0 per cent as referred to the predicted figure. The range was between —15 per cent and +19 per cent. Two per cent were above +10 per cent and 1 per cent above +15 per cent.

Two other observations have been applied in this series of normal subjects for comparison with the hypertrophic hearts of organic disease. The first of these is the retrocardiac space as determined by a lateral orthodiagram. In most unhypertrophied hearts a clear space exists between the anterior border of the spinal column and the posterior border of the heart. No attempt at mensuration has been made, but merely a notation as to whether the retrocardiac space was wide, reduced or obliterated. In the 100 normal subjects the retrocardiac space was widely open in 87 per cent, reduced in 11 per cent and obliterated in 3 per cent. Figure 2 shows the frontal and lateral orthodiagraphic tracings of a normal subject. The other observation referred to above is the measurement of the apparent shift of the cardiac border on shifting the tube away from the observed border a known distance. In practice, a shift of 10 centimeters is used. The apparent displacement results from oblique rays cutting the posterior border of the heart and should give an indication of the antero-posterior development of the heart. This is a modification of a method originally proposed by Vaquez and Bordet (8). Since in most cases of chronic heart disease it is mainly the left ventricle which is enlarged, the apparent shift should be relatively greater on the left in these hearts, as compared with the normal. We have recorded the apparent shift on each side and expressed it as the observed shift on the right divided by the observed shift on the left (R/L). This proportion averages in the normal series 1.49 and was above unity in all but 2 per cent. In the normal heart the apparent movement of the right contour is nearly always greater than that of the left when the tube is moved the same distance from each contour.

MENSURATION IN ORGANIC HEART DISEASE

The table (Table I) and chart (Fig. 1) show the area distributions in 110 cases of chronic valvular heart disease, divided into four groups, mitral stenosis, mitral stenosis and regurgitation, aortic regurgitation, and multiple valvulitis (in most cases combined

mitral and aortic disease). The cases were selected from a much larger number to fulfill the following requirements: (1) that there should be no reasonable doubt that the diagnosis, based on careful clinical study, is correct; (2) that they should give no history or present signs or symptoms of cardiac decompensation and thus be true examples of chronic valvular heart disease.

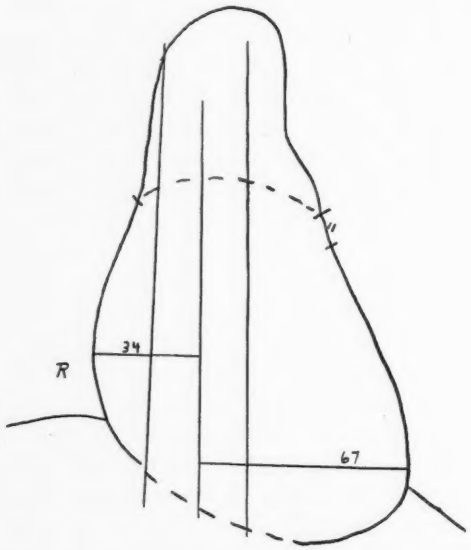

Fig. 2A. Frontal orthographic tracing of normal subject, age 22 years, height 61 inches, weight 115 pounds. Area 86 sq. cm., transverse diameter 101 mm. (normal area 88 sq. cm., transverse diameter 100 mm.). Dashed line indicates contour completed arbitrarily.

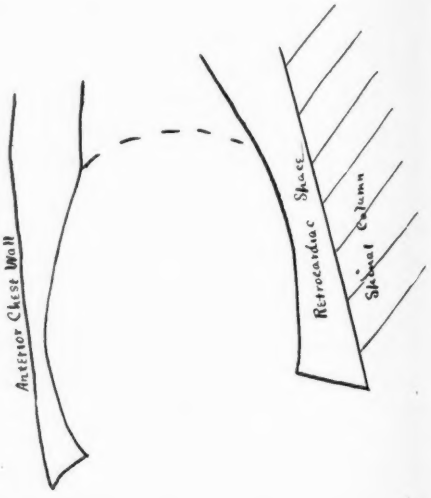

Fig. 2B. Lateral orthographic tracing of same subject as shown in Figure 2A.

MITRAL STENOSIS

In uncomplicated and well compensated mitral stenosis, little or no ventricular enlargement is to be expected. Compensation in this condition is maintained by the left auricle, which is always found to be dilated and hypertrophied. Special X-ray signs, as first described by Bordet, indicative of left auricular enlargement, are found in nearly all cases of mitral stenosis and greatly aid in the diagnosis of this condition. It is beyond the scope of this paper to go into this matter in detail and it must suffice to say that this criterion was applied and accorded with the clinical findings in 94 per cent. If the left auricle fails to maintain perfect compensation in mitral stenosis, an abnormal load falls upon the right ventricle and this probably occurs in many clinically compensated cases. That the pulmonary tension is increased in a large percentage is indicated by the high incidence of accentuation of the pulmonic second sound (82 per cent in this series). One would expect, therefore, to find a tendency to slight ventricular hypertrophy in a series of cases of mitral stenosis, and this is borne out by the cardiac silhouette areas, as is evident from the data presented. The average area from the group is $+6\frac{1}{2}$ per cent, as compared to the normal predicted area, and 78 per cent show a plus variation. Thirty per cent are above $+10$ per cent in area and 8 per cent exceed the upper normal range. The average transverse diameter for the whole group shows almost identical relationships. The

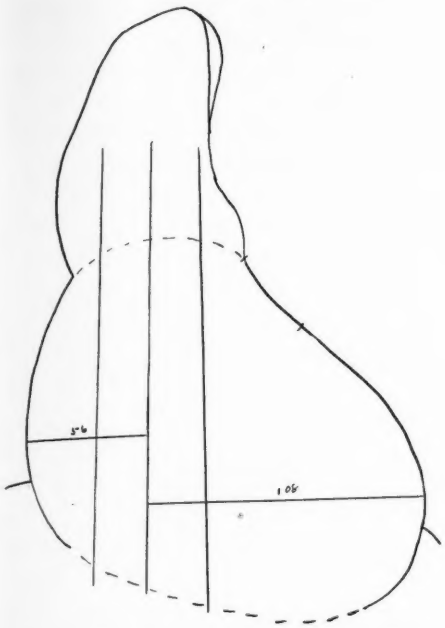

Fig. 3A. Frontal orthographic tracing of subject having diagnosis of mitral stenosis and regurgitation, aortic stenosis and regurgitation, aneurysm of the ascending aorta, aortitis, and adherent pericardium. Area 178 sq. cm., transverse diameter 164 mm. (normal area, according to Hodges and Eyster, 122 sq. cm., transverse diameter 130 mm.).

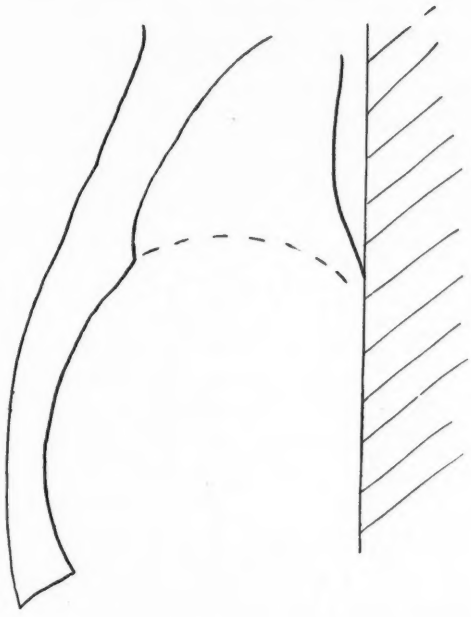

Fig. 3B. Lateral orthographic tracing of same subject as shown in Figure 3A.

R/L ratio averaged 1.38 and was below unity in 12 per cent.

MITRAL STENOSIS AND REGURGITATION

When leakage of the mitral valve develops as well as stenosis, obviously compensation can be maintained only by increased work and hypertrophy of the left ventricle. All of the areas in this group were above the predicted normal and 80 per cent showed an enlargement greater than +16 per cent, the upper normal range. The average area for the whole group is +30 per cent. Eighty-eight per cent of the transverse diameters are above +10 per cent of the predicted diameter. The retrocardiac space was obliterated in 84 per cent and reduced in the remainder. The R/L ratio averaged 1.18 and was below unity in 23 per cent.

AORTIC REGURGITATION

This lesion, typically associated with left ventricular hypertrophy, shows all areas above the predicted normal and 88 per cent above the upper normal range. The average for the group is +34 per cent. Eighty per cent of the transverse diameters were more than 10 per cent above the predicted. The retrocardiac space was obliterated in 60 per cent and reduced in 28 per cent. The R/L ratio averaged 1.27 and was below unity in 43 per cent.

MULTIPLE VALVULITIS

The smallest area in this group is +40 per cent above the predicted: the average is +68 per cent. The lowest transverse diameter was +17 per cent: the average +36 per cent. The retrocardiac space was obliterated in all cases. Figure 3 shows the frontal and lateral orthodiagrams of a case of this series.

MYOCARDITIS

Fifteen cases showing clinical and electrocardiographic evidence of myocarditis without valvular lesions and in good compensation show a rather wide range of areas. It is well known that these cases fall into two pathological groups, the atrophic and the hypertrophic.

MENSURATION IN NON-ORGANIC CARDIAC CONDITIONS

The most interesting group here is 100 cases presenting systolic murmurs without other evidence of cardiac involvement and classified as accidental murmurs. The average of this whole group falls on the predicted normal area and the distribution curve is essentially that of the normal subjects. Three per cent were above the normal range. The data as regards transverse diameter, retrocardiac space and R/L ratio are practically identical with the normal. Twenty-four cases of extra-systolic arhythmia without clinical evidence of valvular or myocardial involvement and twenty-five cases of mild hyperthyroidism without evidence of cardiac failure show an approximately normal distribution. The same findings were obtained in twenty-five cases of neurocirculatory asthenia, which are not included in the present tabulation. A somewhat surprising result was obtained in a group of cases of arterial hypertension without marked arteriosclerotic changes, renal involvement or evidences of myocardial change. A number of these cases were repeatedly examined over a period of several years. While the area distribution shows a distinct tendency to hypertrophy, with an average for the whole group of +17 per cent, and 40 per cent are above the upper normal range, the extent of hypertrophy is not as great as in valvular lesions involving the left ventricle, and a considerable grade of uncomplicated hypertension may exist for a prolonged period without evidence of cardiac hypertrophy.

SUMMARY

The distribution of certain mensurations made from the frontal and lateral orthodiagrams of human hearts in 424 cases of normals and chronic heart disease is presented. These mensurations include the area and transverse diameter of the frontal plane silhouette, and the retrocardiac space in the lateral plane. The former measurements are compared with the prediction tables previously published. It is found that the measurements in cases of clinical hypertrophy differ sufficiently from the normal to conclude that cardiac mensuration is a valuable method for determining the existence of cardiac hypertrophy, and compares favorably in its degree of precision with other useful methods applied to clinical medicine.

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CORRELATION OF X-RAY PLATES, CLINICAL FINDINGS AND BLOOD PRESSURE READINGS IN A SERIES OF 300 CASES[1]

By CHARLES E. IDE, M.D., MILWAUKEE, WISCONSIN

SINCE July, 1925, over 2,700 health examinations have been made for the Employees' Mutual Benefit Association of Wisconsin. Among the X-ray plates taken, there are 300 of the chest, which have been studied with special reference to blood pressure. It is very difficult to know the normal blood pressure or to determine the normal heart size for any given individual, but by comparing the variations of blood pressure at intervals and the cardiac shadow as it appears on several successive X-ray films, it may be possible to reach a definite conclusion.

In each of the 2,700 examinations, blood pressure readings were made from both arms, and any abnormal variation was followed in a few days by a supplementary test. A group of cases was found having an increase in the cardiac shadow in both the aortic and left ventricular areas. These cases had pulse pressures of 80 or over and had, on physical examination, evidence of both aortic and mitral lesions. A group of cases of mitral insufficiency showed an increase of cardiac shadow in the left ventricular area and a pulse pressure of 50 or over, with a slight increase in heart rate and slight dyspnea after exercise. A group of cases of mitral regurgitation with pulse pressure of an average of 40 and blood pressure, systolic, 120 to 135, had no dyspnea on exertion or increase in pulse rate after exercise. Normal blood pressure and pulse pressure with marked enlargement of the cardiac shadow would seem to indicate an adjustment of circulation. Five trained athletes with systolic blood pressure of 100 were examined. It is difficult to say whether in all cases this was a normal low blood pressure or merely a temporary one. High systolic blood pressure, 150 and over, may show evidence of increase in X-ray shadow in both aortic and left ventricular areas. A lowering of systolic blood pressure or a short pulse pressure may be more important than high blood pressure.

A study of X-ray slides of the following groups was made: (1) Those having a pulse rate approaching 90; (2) those with evidence of dyspnea on exertion; (3) those with high systolic or diastolic blood pressure; (4) those with short or long pulse pressure.

Examination of the lungs should precede physical examination of the heart. Careful inspection, palpation, and percussion should always precede auscultation. Special attention should be called to the shape of the chest, any bony malformation, the movement of the costo-sternal angles on inspiration and expiration, deviation of the trachea to the right or left—in fact, any pathological condition of the lungs that would either embarrass the heart's action or change its anatomical position. Percussion and inspection should be given first place in physical examination, and auscultation used to clarify these findings. The internist should realize the limitations of physical examination. He should know the superficial areas that are most accessible. The parenchyma of the lung is most accessible above and below the scapula, along the inner scapular margins, and the outer 40 millimeters on the anterior chest. In diagnosing pulmonary tuberculosis, if these areas were given careful attention, there would be a 90 per cent agreement with the X-ray plate.

A group 20 to 30 years of age having systolic blood pressure approaching 100 or lower, had X-ray evidence of mottling or scar tissue in the upper lobes. Pulmonary

[1]Read before the Radiological Society of North America, at Milwaukee, Nov. 29–Dec. 4, 1926.

tuberculosis differs clinically and, from the X-ray standpoint, according to the age of the patient. The disease should be studied with reference to the heart, at all ages. Before the age of 20, fatigue, dyspnea, and tachycardia may precede medium sized râles in the upper lobe, on physical examination, or mottling evidenced by the X-ray. After the age of 30, X-ray pathology and physical signs may be out of proportion to symptoms. The lowering of the blood pressure is less noticeable than at an earlier age, although dyspnea and tachycardia are usually present on exertion. Increase in the cardiac shadow may be evidence of cardiac dilation in tuberculosis, especially in those cases where there is a fibroid contracted lung, pleurisies at the base of the lung, or pleurisies with adhesions to the pericardium. Tuberculosis elsewhere than in the lung may modify the X-ray pathology and physical signs. Pregnancy may modify in the same way.

Between the ages of 20 and 30, when there is evident mottling of the upper lobes, together with physical and laboratory findings proving the presence of an active pulmonary tuberculosis, there is usually a lowered systolic blood pressure and an increase in the heart rate after exercise. The lungs should be considered as a pulmonary heart, rather than as organs for separate study. Any pathological change in the parenchyma of the lung, whether intra-pulmonary or extra-pulmonary, interferes with the exchange of oxygen and may embarrass the right heart.

On physical examination, any increase of cardiac dullness to the left can be easily substantiated by an X-ray film. Such increase to the right, however, may be more difficult to ascertain by percussion in physical examination, but it may very easily be seen from the plate. Professor Aschoff, of Freiburg, and the late Professor Möncheberg, of Strassburg, according to Stephen d'Irsay (1), state that it has come to be recognized that hypertrophy of the heart does not mean merely a quantitative increase in the number of fibers constituting muscular tissue, nor is it a simple increase in their size. If such were the case, hypertrophy of the heart would be just as physiological as the hypertrophy of any hard working muscle. We would not understand why such a quantitatively strong muscle could give way all of a sudden. But hypertrophy of the heart muscle is, in a sense, always pathological; the intricate metabolism of the fibers is injured, and anatomical proof is forthcoming of *this* injury. Anatomical research also has pointed out another fact of great importance, to wit: that an infection, if it damages the heart at all, damages all its layers, and no individual structure can undergo injury while the others remain untouched.

Recent efforts have been increasingly successful in securing measurements of the heart in three dimensions, and especially since Dr. Cohn of the Rockefeller Institute has introduced a method for registering the movements of the borders of the heart shadow. When such an enlargement of the cardiac shadow is determined by X-ray, it then becomes essential to correlate this fact with the heart rate after exercise, to note the blood pressure, and to compare with the X-ray plates taken of the same subject at different times, in order to find that variation in size has occurred.

Pathologists tell us that lesions at the base of the lung, including pneumonia, abscesses, and adhesions, invariably show dilation of the right heart.

Louis H. Fales (2) states that "Peribronchial infiltration, as seen by the roentgen ray, is of no importance in diagnosing pulmonary tuberculosis, as it was not found in any case in combination with positive sputum." While this finding may be of little importance as far as tuberculosis is

concerned, it is probably of significant value as evidence of the lack of normal elasticity of the lung tissue and of the utmost importance in prognosis of heart lesions, and there is no question but what it entails more difficult work for the right heart.

Success in health examinations depends upon two things: (1) The ability of the internist to understand the relationship of physical signs to certain X-ray densities, and (2) the ability of the roentgenologist to correlate certain X-ray findings with physical signs in the same area. This mutual understanding is essential if the confidence of the patient is to be gained.

CONCLUSIONS

(1) Pulmonary tuberculosis occurring between the ages of 20 and 30 and involving the upper lobes usually shows evidence of lowering systolic blood pressure during the active stage of the disease.

(2) Increase in cardiac shadow may not give definite evidence as to the efficiency or deficiency of the cardiac muscle, but together with the blood pressure reading, the condition of the heart muscle may be ascertained.

(3) Lesions in the lung, other than pulmonary tuberculosis, especially those at the base of the lung, may affect cardiac shadow and also the blood pressure.

It would be of great service to the roentgenologist in taking X-ray films to have an accurate knowledge of the blood pressure readings, of the heart rate after exercise, and the presence of pathological conditions elsewhere in the body that might modify the X-ray densities and help him estimate the individual meaning of his findings. Roentgenologists of this country should have a large measure of credit for the lower death rate in tuberculosis and for their help in making the diagnosis of chest diseases almost an exact science.

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DISCUSSION

Dr. E. W. Miller (Milwaukee): I have a rather selfish interest in the paper of Dr. Ide, inasmuch as the findings of many of these heart examinations that he referred to were studied by me in conference with him. I think it is only just that a word should be said about periodic health examinations and periodic physical examinations. Such examinations are bound to come. Every effort is being made to render that successful. Roentgenologists will have an important part to play in such examinations, and there is no doubt but that they are already making their plans for effectively carrying out their part of this program.

I would not attempt to discuss the heart and lung conditions covered in Dr. Ide's paper. I should like, however, to lay some stress on the value of the X-ray to us in this particular work. I am satisfied that we take many negative films, that is, films that show no real pathology; but this is, in itself, to my mind, a great advantage, since it gives us an opportunity to appreciate and interpret normalcy. It has been my experience that that is a shortcoming on the part of a great many of us; we fail to know the normal in X-ray interpretations, and in that way we frequently miss the pathology. Repeated X-ray studies in health examinations or any other kind of examination are highly essential. May we not feel that X-ray for prognosis is quite as important as the radiograph for diagnosis? Repeated roentgenologic examinations of the same case enable us to determine various phases of pathologic development, and then, in the event that only one film is taken in any given case, we are able to identify that as a particular stage of

pathologic development in a case where a series has not been taken. Dr. Ide has not only checked his own physical findings against the X-ray, but his work has been checked by other members of our staff. I think this is an extremely important matter —not to depend entirely upon the X-ray or physical findings or clinical picture, but to check ourselves in every instance possible against the X-ray as compared with the clinical picture, and the clinical picture as compared with the X-ray. I have felt that in many instances too much stress has been laid on one or the other; I have also felt for some time that there has been some X-ray hysteria in the medical profession, that is to say, X-rays are taken for any and all conditions and sometimes not properly interpreted and a false sense of security is given to a patient. I am not in any way advocating the taking of fewer X-ray films, but the taking of more and interpreting what we find in these. The earlier hysteria is, I believe, quite a matter of history now and the real scientists among us are correlating X-ray findings with clinical findings to the greater advantage of the patient and the satisfaction of the referring physician.

FURTHER STUDIES ON THE INFLUENCE OF RADIATION QUALITY ON THE ERYTHEMA DOSE MEASURED IN PHYSICAL UNITS[1]

By WILLIAM H. MEYER, M.D., and OTTO GLASSER, PH.D.,
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IN a paper entitled "Erythema Doses in Absolute Units" (1), presented at the last Annual Meeting of this Society in Cleveland, we called attention to the fact that the roentgen-ray doses, measured in ionization units, which produce similar reactions on the human skin, are to a marked degree dependent upon the radiation quality employed. At that time we also described our method of skin dose estimation as well as the method of physical dose determination; these shall, therefore, not be dealt with again in this paper, since they have remained the same as formerly described. It should be recalled that our erythema reaction is always accompanied by epilation, which fact was not especially stressed in our former communication on the subject though the erythema dose as here calculated is practically 20 per cent over the epilation dose used in tinea capitis. Most of our doses have repeatedly been transferred to other therapy installations (40 within the last year, in addition to the 70 reported at the Cleveland meeting). The reactions produced with the doses on these 110 machines are, as far as we know, very similar to our own.

Within the last year we have extended our observations, correlating the ionization current, measured in electrostatic *R*-units, with the reaction on the human skin to still softer rays than previously reported, thus finding some interesting phenomena. We also have studied the influence of backscattering from the patient (or water phantom) upon the erythema doses, measured in electrostatic *R*-units. This was done in an attempt to make a more exact comparison of the dosage, as measured with the different ionization units employed in several laboratories in this country as well as abroad.

RADIATION QUALITY

For our experiments we used nine different radiation qualities, starting with an X-ray beam giving a half value layer with somewhat under ¾ mm. of aluminum, produced with approximately 45 peak kilovolts, unfiltered, and going as high as 215 kilovolts, strongly filtered, resulting in an X-ray beam showing a half value layer of over 14 mm. of aluminum. A detailed description of the conditions under which these nine qualities were produced is presented in Table I.

The half value layers in aluminum and copper (given in Columns IV and V, Table I) of the nine radiation qualities were determined by absorption measurements, using a fine X-ray pencil and a large air ionization chamber. The figures obtained correspond closely to those found by a photographic method, recently described by William H. Meyer (2).

CORRELATION OF SKIN EFFECTS AND PHYSICAL DOSE FOR VARIOUS RADIATION QUALITIES

The findings reported last year (1), that the number of electrostatic *R*-units per erythema decreases with decreasing penetration of the rays (using qualities C to I in Table I) were again confirmed. The same observation has been reported by other investigators (Dessauer 3, Gruhn 4, Dieterich 5, Wintz and Rump 6, Glocker 7, Sievert 8). But extending our observations to still softer rays (qualities A and B in Table I) we found that beyond a certain limit, which occurs around quality C, the number of *R*-units per erythema again increases rapidly. Illustrating this effect, Table II gives the erythema doses measured in the electrostatic *R*-

[1]Presented before the Radiological Society of North America, at Milwaukee, Nov. 29–Dec. 4, 1926.

TABLE I

I Radiation	II Peak Kilovolt	III Filter in mm.	IV Half Value Layer in mm. aluminum	V Half Value Layer in mm. copper
A (soft)	45	1 fiber	0.65	
B	75	1 "	0.81	
C	100	1 "	1.00	
D	130	1 "	1.72	
E	130	2½ Al.+ 2 "	3.80	0.13
F	130	4½ Al.+ 2 "	5.35	0.21
G	130	¼ Cu.+ 1 Al.+ 2 "	7.55	0.36
H	130	½ Cu.+ 1 Al.+ 2 "	9.50	0.55
I (hard)	215	¾ Cu.+ 1 Al.+ 2 "	14.75	1.18

units as used at present in our laboratory; Column II shows the doses as measured directly on the patient as well as by means of a phantom. These measurements include, therefore, the backscattering from the patient. In all the doses referred to, the total range of focal distance was from 30 to 50 cm. and the sizes of area exposed from 15 × 15 to 20 × 20 cm. Column III gives the measured doses without backscattering (the ionization chamber suspended freely in air).

A graphic representation of these data in relation to the radiation quality (half value layer in aluminum) is shown in Figure 1.

As shown in Figure 1, the two curves, *a* and *b*, correlating the erythema doses in *R*-units with various radiation qualities, reach a minimum at approximately an X-ray quality showing a half value in 2 mm. of aluminum and ascend towards the harder as well as the softer ray side. While according to our present knowledge the curves reach a maximum with the hardest X-rays and continue at this maximum with the gamma rays of radium, it is likely that after reaching a maximum with the soft rays the curves may again drop. Experiments to study this probability are now under way.

TABLE II

I Radiation	II Electrostatic *R*-units per Erythema: On the patient (with backscatter)	III Electrostatic *R*-units per Erythema: In air (without backscatter)
A (soft)	750	720
B	620	560
C	520	450
D	480	400
E	700	520
F	810	600
G	930	690
H	1100	800
I (hard)	1300	900

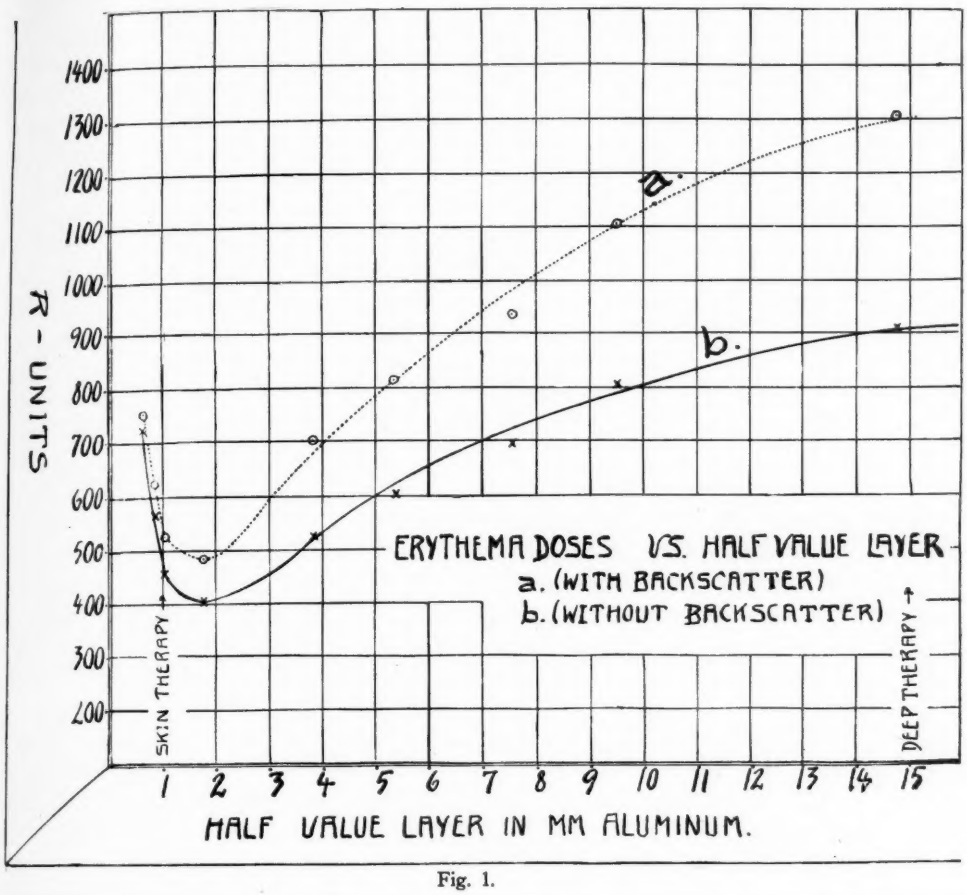

Fig. 1.

Part of the phenomena as illustrated in Curve *a* of Figure 1 is, of course, due to backscattering, the amount of which decreases relatively with the decreasing penetration of the rays. It is for this reason that we added in Curve *b* the same relationship of radiation quality and doses in *R*-units, which curve gives the data without backscattering. Here, too, the difference in the doses at different wave lengths required to produce the same effect on the human skin varies to such a degree as to permit the important conclusion that, *measuring by ionization in air and using large portals of entry, the same number of ionization units will not result in the same skin reaction when rays of varying qualities are employed.* This statement appears at variance with the results of several other investigators and a discussion of the reasons for these discrepancies will be published in the near future.

Here we wish to cite an example of one of the best known series of experiments *in re* this problem, namely, that of F. C. Wood (9), who presented his data before this Society two years ago. Wood, in his most careful and elaborate experiments, uses, as you will recall, two bundles of homogenous radiations of the wave lengths 0.2 and 0.6 Ångström unit, respectively. He gives identical doses, measured by ionization in air, to cancer and sarcoma cells, which cells were subsequently inoculated

into rats. From the fact that he obtained almost identical effects from both qualities of radiation, Wood draws the conclusion that rays of all wave lengths, applied with the same ionization dose, will have similar biological effects. Our own results do not agree with this deduction, at least so far as the human skin is concerned. In studying Curve *b* in Figure 1 we find that with the two wave lengths employed by Wood (0.2 and 0.6 Ångström unit corresponding to half value layers of 9.5 and 0.79 mm. of aluminum, respectively) there are two points where practically the same number of *R*-units will result in the same skin reaction. However, the extension of our observations to a number of other qualities permitted us to state that an error would result in drawing general conclusions from limited observations on the qualities employed, when such a wide variation in the number of *R*-units over the whole range of qualities occurs. However, the conclusions of these latter findings were deducted from the radiation effects on the human skin when using large areas, although it is quite possible that when employing small skin areas or small biological specimens the variation of biological effect with various radiation qualities is very small, if not negligible.

ERYTHEMA DOSES IN *R*-UNITS DIVIDED BY HALF VALUE LAYER IN WATER

A finding of some practical value appears from our data which we cannot at present satisfactorily explain, though we have some theories on the matter. We found that for many of the radiation qualities used for therapeutic purposes, the number of electrostatic *R*-units per erythema (measured without backscattering, see Column III in Table II), divided by the half value layer in water (measured on a fine X-ray pencil), is within ± 5 per cent a constant. The average value of this constant is 235 for the electrostatic *R*-units as used at present in our laboratory. Table III shows these data as observed.

The practical value of this relation $R/h = 235$ is the following: If the half value layer in water of any X-ray beam (within the range indicated in Table III) is known, its product with 235 will furnish the number of *R*-units for that special radiation quality which is necessary to produce an erythema reaction of known degree on the human skin.

BACKSCATTERING AND THE COMPARISON OF ELECTROSTATIC UNITS OF DIFFERENT LABORATORIES

In former papers (10) we have made the statement: It is advisable when calibrating different machines, different tubes, etc., to have the ionization chamber freely suspended in air. To measure the erythema dose, however, the ionization chamber ought to be placed there where the erythema is produced, *i.e.*, on the skin of the patient.

TABLE III

I Radiation	II Half Value Layer in cm. Water: *h*	III *R*-units per Erythema: *R* (without backscatter)	IV Quotient *R/h*
D	1.72	400	233
E	2.11	520	246
F	2.50	600	240
G	3.02	690	228
H	3.36	800	238
I (hard)	4.03	900	223

A discussion as to which method is to be preferred has since taken place in the literature. We are still of the same opinion, as stated above, and believe that for calibrations the large air ionization chamber is to be preferred, while for the exact determination of erythema doses we have to measure on the patient or a phantom with a small ionization chamber. It seems as if the small air wall ionization chamber, as demonstrated before this Society by Fricke and Glasser three years ago at the Rochester meeting, is the most satisfactory type of a small chamber. It has been improved recently and constructed in a more robust form by Glocker (7), who strongly recommends its use for standard purposes. We are indebted to Dr. Glocker for sending us one of these chambers. All iontoquantimeters ought to be equipped with chambers of such material, instead of chambers with walls of substances of unknown or impure chemical composition, which show a decided but mostly uncontrollable influence of the radiation quality upon the ionization current. With such standard chambers erythema doses ought to be determined right on a large number of patients before we can arrive at a reliable comparison of the doses given in different institutions, using various constructions of instruments. Since many radiologists publish their doses without backscattering, *i.e.*, with the ionization chamber freely suspended in air, we also added these doses in the tables given above.

Last year we presented a number of erythema doses measured in different laboratories, with the purpose of demonstrating that these doses agree fairly well. Unfortunately, further investigation into the problem of comparing doses given here and abroad reveals some difference between the units used at different places. We tried to compare such units either directly in the different laboratories or by means of well controlled calibrated instruments. The former was done with the units used here in the United States, the latter with the unit used throughout Germany. Through the kind co-operation of Dr. Duane, Dr. Bachem and Dr. Arens we were able to compare their units with ours in their laboratories. The result was that Duane's electrostatic unit agrees with our *R*-unit within 5 per cent, Bachem's electrostatic unit and ours within 9 per cent, while the unit used by Beets and Arens is equivalent to 1.8 of our units. We also proceeded to compare the German *R*-unit (Behnken, 11), as laid down in five different imported calibrated German dosage instruments, with our unit. The units of these five instruments did not agree very well among themselves. The most reliable of the instruments was the Kuestner Eichstandgeraet (12), which is controlled by radium. The German *R*-unit given by this instrument is 45 per cent higher than our electrostatic *R*-unit. In other words, our erythema dose of 1,300 *R*-units on the patient, or of 900 *R*-units without backscattering, using hard filtered rays, corresponds to approximately 620 Behnken *R*-units as used in Germany. This latter figure agrees closely with the doses reported in Germany. Since the comparison of the different units is of great significance for the problem of standardizing the roentgen dose, we will in the near future report the details of this part of our work in a special publication.

CONCLUSIONS

(1) Measuring by ionization in air and using large portals of entry, the same number of ionization units will not result in the same skin reaction, when rays of varying qualities are employed.

(2) The curve correlating the erythema doses in electrostatic *R*-units with various radiation qualities reaches a minimum at approximately an X-ray quality showing a half value in 2 mm. of aluminum and ascends towards the harder as well as the softer ray side.

(3) For many of the radiation qualities used for therapeutic purposes the number of electrostatic *R*-units (measured without backscattering), divided by the half value layer in water, is within ± 5 per cent a constant.

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THE ANALGESIC PROPERTY OF ROENTGEN RAYS[1]

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THE increasing usefulness of roentgen rays in the diagnosis and treatment of many forms of disease is well known, but it is not so well known, if we may judge by the comparative paucity of references in the current literature, that these rays, in common with certain others, such as ultraviolet rays from natural or artificial sources, possess a definite analgesic property. That physicians in general, and radiologists in particular, are not more familiar with this property is perhaps due to the circumstance that it is seldom so striking as to stand out clearly above the other effects of irradiation or that its manifestation is often linked so closely with such effects as to appear to depend on, and to be secondary to them.

REVIEW OF THE LITERATURE

As might be expected, the animal experiments bearing on this question are extremely meager, because it is no simple matter to estimate or to determine in animals the degree of a subjective sensation such as pain. The studies of Swann indicate that small doses of roentgen ray increase the irritability of nerves whereas larger doses diminish it, but his experiments were not prolonged sufficiently to establish the constancy and duration of the increased irritability noted after small doses. The remarkable experiments of Hesnard, by which he demonstrated that radiotherapy has a definite and favorable effect on the healing and an indirect effect on the regeneration of traumatized nerves, are interesting, but have no particular bearing on the analgesic property of roentgen rays. The same is true of the experiments of Horsley and Finzi, Bagg, Pendergrass, Hayman, Houser, Rambo, and many others who have investigated, not the irritability of nerves as affected by irradiation, but the pathologic alterations produced in brain or nervous tissue by irradiation. However, in spite of the limited number of animal experiments, the clinical evidence which has accumulated cannot be lightly cast aside. Thus, within a few months following Roentgen's announcement of the discovery of the X-rays, Despeignes (1896) reported the case of a patient who supposedly had advanced carcinoma of the stomach, with epigastric pain, who derived much relief from roentgen-ray treatment. Although, in the light of present knowledge, it appears likely that this patient was suffering, not from carcinoma of the stomach, but from retroperitoneal lymphosarcoma (retrogression of the tumor was more rapid and more marked than in carcinoma according to the generating apparatus and tubes then available), the relief from pain was, nevertheless, unmistakable and undoubtedly due to the rays. In 1897 Gocht reported one case of trigeminal neuralgia, and two of mammary cancer, in which an apparently definite analgesic effect was obtained. Stembo (1900) reported having cured by roentgen-ray treatment twenty-one of twenty-eight patients with neuralgia. Grunmach (1900) irradiated patients with facial, cervical, and intercostal neuralgia, and with articular rheumatism, with varying results. He noted definite analgesia in many, but believed it was not a specific action on sensory nerves; he attributed it rather to the effect of light and heat. Sjögren and Sederholm (1900-1901) recorded four cases of pruritus ani and pruritus vulvæ and eleven cases of chronic eczema in which relief from itching had followed such treatment. Since then a large number of cases has been reported in which roentgen rays have abolished itching in pruritus, associated with various diseases of the skin, or with its simple sensory nerv-

[1]Read before the Radiological Society of North America, at Milwaukee, Wisconsin, November 30, 1926.

ous disturbances, or neuralgic pain in different parts of the body (sciatic, trigeminal, intercostal, and so forth). Among these may be mentioned the cases reported by Skinner (1902), Allen (1902), Sweet (1902), Guilleminot (1903), Delherm and Laquerrière (1904), Pennington (1904), Belot (1904), Gramegna (1905) and Leonard (1905). In 1908 Babinski reported a case of spondylosis in which marked attenuation of neuralgic pain followed radiotherapy. Since then the literature has contained an increasing number of reports of the analgesic action of roentgen rays in neuralgia among which are those by Zimmern and Cottenot (1912), Delherm and Py (1912), Simonson (1913), Eckstein (1914), Wilms (1918); many others followed in rapid succession.

The War, which transformed millions of men into soldiers and which altered so profoundly the life of the nations involved, provided an opportunity to test this property of roentgen rays in the spasmodic and sensory disturbances accompanying many traumatic injuries of peripheral nerves. In 1915 Cestan and Descomps called attention to the effect of the rays in these conditions, and recorded fifty-four cases, in about 50 per cent of which improvement or cure had followed roentgen-ray treatment. Bonnus (1916) also had a satisfactory experience with spasmodic conditions due to gunshot wounds of the spinal cord and with the painful manifestations of gunshot injuries of peripheral nerves and their roots. In the same year Hesnard reported similar results under like circumstances, but he also showed, by an interesting series of animal experiments, how roentgen rays alter the connective tissue in and around the injured nerves and facilitate the regeneration of such of the nerve fibers as have not been hopelessly damaged. Since the War many more reports have been published showing the capacity of roentgen rays to diminish the irritability of nerves.

ANALGESIC ACTION OF ROENTGEN RAYS ON TUMORS

This analgesic property of roentgen rays is a matter of daily observation in the radiotherapy of benign and malignant tumors. In fact, abolition or diminution of pain is often the first sign of the effect of the rays noted by the patient, and this may occur quite early, before any change in the size of the tumor can be perceived. Indeed, it is not uncommon for relief from pain to begin during a course of treatment. I have even seen cases in which pain of long standing disappeared overnight, after the first session of a course of radiotherapy. To the initiated this anodyne action of roentgen rays constitutes an indication for the use of irradiation, not only in cases in which it may be expected to exert a marked inhibitory influence on a tumor, or to cause its complete retrogression, but also in advanced and hopeless cases in which relief from pain is the only object of the treatment. Unfortunately, analgesia is not always obtained, either because the factor responsible for the pain has not been localized accurately and treatment has not been directed to the proper region, or because the pain-producing factor is such as not to be effectively overcome by treatment. It is true that irradiation as a pain eradicator is not uniformly successful, and we are not yet able to determine definitely beforehand which cases are likely to derive benefit. However, it is possible to make certain broad generalizations. For example, pain due to the pressure exerted by a tumor on nearby nerves is commonly relieved by adequate irradiation of the region occupied by the tumor. Pain due to pressure on or irritation of nerve roots by contiguous metastatic foci is usually controlled by irradiation. Such control may be permanent or only temporary, and this does not seem to be absolutely dependent on the subsequent behavior of the neoplastic process.

REPORT OF CASES

Case 1.—A girl, aged fourteen, was brought to the Mayo Clinic July 22, 1926, because for the last two years she had had swelling of the left thigh, pain, especially on walking, and stiffness in the left lower abdominal quadrant. The child was weak and anemic; she limped and the left thigh was semiflexed and swollen so that she was forced to use crutches. A tumor, measuring approximately 9 by 13 cm., was palpable in the left groin, principally above the fold and along the inner aspect of the left ilium, to which it was fixed. No biopsy was done. The tumor was considered inoperable and the patient was referred for radiotherapy. The result of roentgenologic examination of the spine (July 26) was negative, except for bifurcation of the left transverse process of the fifth lumbar vertebra. The roentgenogram of the thorax gave negative information. A course of high voltage roentgen-ray treatment was given from August 3 to 5. This was directed to the left half of the pelvis through three fields, each receiving the following dose: 200 peak kilovolts; filtration, 0.75 mm. copper and 1 mm. aluminium; distance, 50 cm.; ma., 5; time, one hour. The patient returned September 16, with complete relief from pain since the previous treatment. The tumor was no longer tender and it had so diminished in size that it was scarcely perceptible on palpation. There was still a slight limp, but the patient had gained 12 pounds in weight. Her family physician wrote on October 19 that there had been steady improvement, with no return of pain.

The impression sometimes obtains that there is a connection between the known radiosensitiveness of different varieties of tumor and the rapidity with which analgesia follows radiotherapy. Such relationship undoubtedly exists, but this factor alone seems hardly sufficient to account for the extremely rapid analgesia occurring in certain cases.

Case 2.—A man, aged thirty-six, registered at the Clinic June 9, 1926, complaining of pain in the epigastric region radiating to the lumbar region as well as to both hips. Right orchidectomy had been performed elsewhere in March on account of a tumor. On examination, a large nodular epigastric tumor was found, and a diagnosis of retroperitoneal metastasis from the tumor of the right testis was made. A course of mixed high and moderate voltage roentgen-ray treatment was given between June 15 and 19. The pain began to diminish during the first day of treatment and had disappeared by the time the course of treatment was completed. The tumor also disappeared in the course of the next few weeks; there has been no recurrence of it and the patient has remained free from pain.

Case 3.—A man, aged forty-five, registered at the Clinic July 19, 1926, complaining of backache which had begun six months previously in the sacro-iliac region. It started after exposure to cold and damp weather, during a journey. The pain was dull and aching, was worse on motion, and had been increasing during the previous three months. During the last two years he had also noticed slightly painful swelling of the right testis, but there had been no recent growth. The patient did not remember having sustained any injury to this organ. He had lost 15 pounds in weight. The blood count was normal and the results of urinalysis and the Wassermann test were essentially negative. Physical examination disclosed bilateral enlargement of the inguinal glands and irregular enlargement of the right testis, suggesting that the pain in the back may have been due to metastasis to the lumbar retroperitoneal lymph nodes. July 24, right orchidectomy was performed and microscopic examination of the excised organ revealed carcinoma, graded 4. August 3, the patient became aware of an abdominal mass occupying the epigastrium,

chiefly the umbilical region. This mass was irregular and distinctly nodular, and undoubtedly represented enlarged retroperitoneal lymph nodes. Apparently this was a metastatic process from the tumor recently excised from the right testis and the backache was due to the metastasis. Between August 3 and 6 the patient was given a course of high voltage roentgen-ray treatment through one anterior and one posterior field, both extending from the level of the nipples to the level of the anterior superior spine. This course of treatment required four days. The pain in the back, from which the patient had suffered for months, began to diminish immediately after the first session, which lasted forty minutes, and by the time the course was completed the pain had completely and permanently disappeared. The tumor likewise disappeared and the patient is still in good condition.

It is true that only a small percentage of malignant tumors are permanently cured by surgical means, by roentgen rays or by any other method; nevertheless, the usefulness of such methods of treatment, in experienced hands, is generally recognized. No one would think of condemning surgery because the majority of malignant tumors subjected to surgical intervention kill the patient notwithstanding, through recurrence or metastasis. Nevertheless, the results of such treatment by experienced surgeons are sufficiently good to be decidedly worth while, if only for the temporary relief they often afford. The same is true of radiotherapy. Indeed, if ability to cure many diseases permanently were to become the criterion by which the value of any method of treatment is to be determined, many of our vaunted modern therapeutic measures would have to be cast aside as useless. But, like surgery, radiotherapy is sufficiently useful to deserve an important place in the treatment of malignant and many benign varieties of neoplasm, not to speak of nonneoplastic diseases, in some of which it is the treatment of choice. The pain incident to metastatic carcinomatous deposits in bone (such as occur in the spine from carcinoma of the breast or uterus) or to metastatic invasion of para-aortic lymph nodes, is so commonly abolished by roentgen-ray treatment as to render it of the greatest value, regardless of the fact that relief, even from pain, is seldom permanent.

Case 4.—A woman, aged fifty-eight, registered at the Clinic December 3, 1924, complaining of a lump in the right breast first noticed in July. In August, this lump had become somewhat painful and since then had slightly increased in size. Examination led to the diagnosis of carcinoma of the right breast. December 8, radical amputation of the breast was performed. Microscopic examination of the excised tissue revealed carcinoma graded 3, with moderate involvement of the lymph nodes. Between December 24 and 27 a course of roentgen-ray treatment was given and this was repeated January 20 and 21, 1925. The patient was examined again May 28, but was found free from recurrence. She returned June 22, 1926, and stated that in December, 1925, she had begun to suffer from pain in the left side of the chest which lasted three or four days, and that pain had developed in the lumbar region. This was in the nature of a steady ache which was worse when she was shaken up, as in riding over country roads or when bending backward. The pain radiated to both thighs. She had received osteopathic treatment with but slight relief. General examination failed to disclose superficial recurrence and roentgenologic examination of the thorax revealed no metastasis, but examination of the lumbar spine showed destruction and flattening of the first lumbar vertebra, probably from metastatic invasion; this undoubtedly accounted for the pain. July 1 and 2 the patient was given a course of high voltage roentgen-ray treatment through the lower dorsal, lumbar

and sacral regions. This was done through two large fields, each receiving the following dose: voltage, 200 peak kilovolts; filtration, 0.75 mm. copper and 1 mm. aluminium; distance, 50 cm.; ma., 5; time, 70 minutes. July 9 the patient wrote that all pain had disappeared and that she was feeling entirely well. Her physician wrote later that she had remained free from pain.

There can be no doubt concerning the relief from pain following radiotherapy, in the cases cited. However, if the evidence of the analgesic action of roentgen rays consisted only of cases such as these, one might be tempted to consider it secondary to the effect on the tumor produced by the rays. But, aside from having a favorable effect on benign and malignant tumors, they exert a distinct and often pronounced analgesic action on conditions entirely unrelated to tumors. For example, corns and callosities about the feet treated with roentgen rays are sometimes almost immediately rendered painless. Relief may come within from twelve to twenty-four hours in certain cases. It is not a uniform result of irradiation but it is sufficiently common to be of distinct value. Another striking example is perianal pruritus, which is commonly due to constipation, diabetes, hemorrhoids, anal tags, and so forth. When the itching is caused by one of these conditions roentgen rays exert little or no effect on it; but when no such condition exists and the itching seems due to hypersensitiveness of the skin itself, roentgen rays are almost invariably effective in diminishing or in completely abolishing the pruritus. Moreover, in some cases the itching disappears overnight.

Case 5.—A physician, aged sixty-two, began to suffer painful defecation in August, 1921. He thought this due to a small hemorrhoid which he successively injected with carbolic acid, iodin and alcohol, after which the anal lump sloughed. For a time he felt relieved. Later the same symptoms recurred, but treatment with artificial light caused them to subside again. Still later, following an outing, he began to suffer from intense perianal itching, and blisters appeared. He was treated by vaccine and hot injections for three weeks, but the itching continued and at times was sufficiently intense to be extremely distressing. The patient consulted several dermatologists, one of whom placed him on a rather stringent diet, and as a result he had lost a little weight and felt somewhat weak. The itching was so severe that for many days at a time it prevented him from doing his usual work as a physician simply because he could not leave the house. Examination failed to disclose any lesion which might serve as a cause for the pruritus. For a period of two weeks he was given vaccine treatment without result. Radiotherapy was then given to the entire perianal region February 16, 1922, the dosage consisting of 1 MacKee skin unit of roentgen rays generated at 80 peak kilovolts, at a distance of 40 cm., without filtration, 6 ma. being given for four minutes. The patient reported distinct improvement by the next morning and this continued steadily. Treatment was repeated March 9. When he was seen again April 4 he had had no itching until four days previously, when it had reappeared in a mild form. A third treatment was given. Following this the itching entirely disappeared and the patient was able to resume full activity and gained 12 pounds. Freedom from itching continued until October, 1922, when it returned but was not sufficient to cause distress. Roentgen-ray treatment was given October 24, 1922, January 3, February 20, and December 13, 1923. Following each treatment the relief obtained from itching was almost instantaneous and lasted for a prolonged period. Since 1923 the patient has been entirely relieved.

Still another condition in which the analgesic action of roentgen rays sometimes helps to relieve the patient from suffering is chronic arthritis.

Case 6.—A man, aged thirty-one, registered at the Clinic August 12, 1926, complaining of pain in the back which had persisted about six years. He presented the symptoms of multiple hypertrophic arthritis, chiefly in the spine, causing pain in the lower dorsal and upper lumbar regions. Roentgenologic examination of the dorsal spine showed hypertrophic arthritis. Roentgen-ray treatment August 19 was given at moderate voltage (135 peak kilovolts), with filtration 6 mm. aluminium, at a distance of 40 cm., with an intensity of 5 ma. for 30 minutes. This was directed to the lower dorsal and lumbar regions. Two days later the pain in the back began to diminish and disappeared completely within a few days. The pain has not returned since, the only persisting symptom being stiffness in the upper and lower extremities.

Radiologists generally are well aware of the astonishing abortive effect of roentgen rays on early furuncles and carbuncles, but, apart from this remarkable influence, the rays in most cases produce rapid and profound analgesia. We cannot yet explain satisfactorily why similar, but more advanced, lesions do not behave in the same way. Fortunately, the maximal degree of pain in these conditions is associated with the earlier stages of their development. The radiologist is thereby enabled to perform two good deeds at the same time, if the patient is referred to him in good season.

There are still other painful conditions with possibly obscure diagnosis in which pain may be abolished by means of roentgen rays to the great relief of the patient.

Case 7.—A woman, aged thirty-six, well-developed, well-nourished and with a well-balanced nervous system, developed a mild respiratory infection, with laryngitis, some three or four weeks before the term of her first pregnancy. March 2, 1923, she gave premature birth to an otherwise normal child weighing 5 pounds 1 ounce (after a rather severe and partly instrumental labor). March 5, she contracted follicular tonsillitis. During the following two or three weeks phlebitis of the left lower extremity supervened. It gradually subsided, leaving no soreness or tenderness at the time. However, as soon as she left her bed and began to walk she began to suffer from aching and weakness in both feet and much pain around the heels. This pain was quite severe, especially when she got up in the morning, but there was a dull ache at all times. An orthopedic surgeon considered the possibility of flat-foot as a cause and tried various measures, including baking, which was continued for a month without relief. Walking tended to increase the pain; indeed, at times walking was unbearable. Since it was thought that infection of the tonsils might possibly account for the distress, these organs were excised in September. Finally, obtaining no relief from any of these measures, the patient was referred for a test of radiotherapy. Both feet and ankles were exposed to roentgen rays generated at moderate voltage (135 peak kilovolts, measured by the sphere-gap method), at a distance of 40 cm., with filtration of 4 mm. aluminium, each of four fields receiving 5 ma. for twenty-two minutes. This was done October 10. By November 1 the patient reported great relief although she still felt some pain in the right heel and still limped slightly. The roentgen-ray treatment was repeated November 1, and by December 12 the pain had diminished still further. She was now able to walk almost naturally, with little pain occasionally. Eleven days after this second course of roentgen-ray treatment she noticed a sensation such as might have been caused by projecting nails in her shoes. She went to her shoe dealer, who changed the inner soles of the shoes, but the sensation continued unabated. Two days later chilblains appeared on the right foot, but these rapidly subsided and the prickling sensation disappeared, the only persistent manifestation being a small

area of anesthesia on the inner aspect of the right foot. January 8, 1924, the patient was given a third course of roentgen-ray treatment and since that time has been entirely free from pain.

The cases here recorded are but a few of a large number in which this specific property of roentgen rays has been successfully employed to relieve suffering under conditions which made other forms of treatment less effective or of little avail. They have been selected to illustrate that the roentgen rays possess an analgesic property which may be applied advantageously in various conditions.

MECHANISM

If this power of roentgen rays to abolish pain were observable only in the case of tumors subjected to radiotherapy we might be tempted to consider this effect as secondary to the primary action of the rays on the tumor itself. We might have some reason to believe, for instance, that the relief from pain is due to the release of sensory nerves from pressure by a tumor. One circumstance seems to suggest the possibility that release from such pressure may play a major part in the anodyne effect of irradiation: the radiosensitiveness of a tumor appears to bear some relation to the rapidity of the analgesic effect. Thus, lymphoblastomatous tumors and the primary and secondary tumors of malignant embryoma of the testis are extremely sensitive to irradiation, and relief from pain in such cases is exceptionally rapid. The very prompt action of irradiation on lymphocytes in general, an effect perceptible microscopically as early as three hours after exposure, might serve to account for the early regression of such tumors and for the release of sensory nerves from pressure of the tumor. However, this explanation is not so satisfactory when applied to malignant embryoma, because, although the spermatogonial cells of the testis are quite susceptible to irradiation, their sensitiveness is not so great as that of lymphocytes, and microscopic evidence of reaction is subject to a longer latent period, a circumstance which makes it difficult, on the basis of release from pressure, to account for the rapid relief from pain instanced in Cases 2 and 3.

Although it is possible that some such process may be a factor in the analgesic action of roentgen rays, we may question how much importance should be attached to it if we consider the great rapidity with which pain is relieved by radiotherapy in conditions which have nothing to do with tumors, such as furuncle and carbuncle. Here pain is commonly abolished within twelve to twenty-four hours. But again, it is possible that release of sensory nerves from pressure may have a bearing on the cessation of pain. One of the chief pathologic features of such lesions is the mobilization of leukocytes around the infectious focus in order to neutralize the toxic action of the bacteria and to prevent them and their toxic products from gaining access to other regions. A large proportion of the leukocytes thus mobilized are lymphocytes, and it is possible that the destruction of such lymphocytes by irradiation may so relieve the pressure on the sensory nerves as to remove the chief cause of pain.

Before we can accept such a hypothesis, however, we should be able to prove that the pain is due to pressure on sensory nerves, but such proof has not yet been furnished. Moreover, when we attempt to understand how roentgen rays so quickly relieve the itching in many cases of perianal pruritus, the pain of neuralgia, and the spasmodic manifestations associated with certain traumatic injuries of nerves, we find it difficult to see how the analgesic effect of the rays in such cases can be other than a true specific action on the nerve cells. Here, it would seem, pressure on sensory nerves can hardly be invoked as the cause of

pain. In many cases of cutaneous pruritus rapidly relieved by roentgen-ray treatment, no evidence of inflammatory change is perceptible. This is also true in many cases of neuralgia. Nevertheless, it is conceivable that, in spite of clinically unrecognizable alterations, the sensory nerves in such cases may be undergoing irritation by extrinsic or intrinsic inflammatory phenomena of low grade, and that the analgesic action is brought about by an influence of the rays on the inflammatory cells. On the other hand, there is evidence that nerve cells, which, of all the cells of the body, are the most resistant to irradiation so far as functional or organic damage is concerned, are acted on in a specific manner and their irritability diminished by irradiation. But, whatever may be the mechanism by which roentgen rays abolish pain in many conditions, there can be no doubt that these rays do possess a definite analgesic property.

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DISCUSSION

DR. HERMANN WINTZ (Erlangen, Germany): The results which Dr. Glasser has reported to us here to-day and his previous results, already published, undoubtedly offer a valuable contribution—

(*a*) To the question of standardization;

(*b*) To the question of different biological effects of rays of different qualities.

Recently the question has arisen whether equal quantities of X-rays have different biological effectiveness, if their hardness is different.

In order to undertake the solution of this problem at all, it is essential to define what is meant by the term "equal quantities."

From the physical point of view it would be most correct to compare equal quantities of energy of hard and soft radiation in regard to their biological action; that is to say, equal amounts of primary radiation energy which are projected onto the body, since our knowledge of the quantitative and qualitative behavior of these equal quantities of energy within the body is very limited.

Absorption, classical scattered radiation, Compton's scattered radiation and secondary radiation developed within the body, will give rise to most varied changes.

The ionization method, which is not at all an energy measure, is generally used for dosis measurements. I myself have used for many years the iontoquantimeter for this purpose. Soon I noticed that, although the doses were ionometrically equal, soft rays required a shorter time of exposure than hard rays.

Generally I use a voltage of 180–200 K.V. and filters of 0.5 mm. zinc plus 3 mm. aluminum. For this radiation the erythema dose had been definitely determined through long series of observations. If I used, with the same voltage, only 3 mm. aluminum, the dose would be too large; with 1 mm. zinc plus 3 mm. Al. the dose would be too small. Long continued experiments showed that with the soft radiation the time had to be reduced 33 per cent, whereas it had to be increased 20 per cent with the hard radiation. On account of these discrepancies which made the determination of the dosage very difficult, I looked round for some other measuring medium. After lengthy experiments a fluoroscopic screen made of Willemit (zinc-silicate) proved to be exceedingly useful. The result of these experiments was a dosimeter which we have called Roentgen-photometer. The brightness of such a screen is not only fully proportional to the intensity of the rays of equal quality, but it also runs parallel to the reaction of the skin when using different qualities of radiation.

This has been proved by treating adjacent fields with radiation of different qualities which, however, gave equal brightness of the screen. The result was absolutely equal tanning of the skin. If one compares, however, the brightness of the screen with the true air ionization, one obtains a curve which shows that, with equal ionization, the brightness of the screen is less with hard rays; then it rises to a maximum brightness at soft rays of about 0.3 to 0.4 Ångström unit mean wave length and drops again after that. This sensitivity is, therefore, exactly the same as that observed by Dr. Glasser with regard to the skin.

The great value of the observations of Dr. Glasser consists, however, to my mind, in the fact that he has succeeded in finding a correlation between the standard dose and the sensitivity of the skin, with regard to rays of different qualities. Determining the dosage according to the standard value *R* has doubtless the disadvantage that the figures for *R* vary if the qualities of the rays vary. Consequently one was forced, in practice, to determine new values for the indurance capacity of the skin and other tissue in accordance with the biological result. According to the results of Dr. Glasser and Dr. Meyer it is now possible to determine, for an unknown quantity of radiation, only

its half value layer in water; the product of this value and of the constant factor 220 then shows the number of *R* necessary to produce the erythema.

That we are still far from really standardizing the measurement of X-rays results from the fact that the measurements of Dr. Glasser show that 800 *R* of primary radiation are necessary for the erythema, while we have fixed this value at 500 *R*. This discrepancy has not yet been cleared up. According to the correspondence with Dr. Glasser on this subject it seems that the biological results and the times of radiation obtained by him and by myself, under conditions as nearly equal as possible, are about the same. The difference lies, therefore, it seems to me, in the measuring instrument.

Measurements with small ionization chambers, especially with walls of material of higher atomic weight, have—in comparison to measurements with pure air ionization—coincided in showing that all these reactions show a maximum at a wave length of 0.2 to 0.3 Ångström unit.

It is clear that the different characters of skin reaction and air ionization lead to serious complications of the dosage problem if air ionization forms its base. Furthermore the conclusion seems justified that the differences of the measuring instruments must be decisive for the biological reaction although the single measuring instruments may indicate, purely physically, absolutely equal values; because each measuring instrument has, in accordance with its particular construction, a special relation to the biological reaction. This is due to the fact that with hard rays the Compton electrons of the scattered radiation play a special rôle. These electrons are only slightly accelerated but travel still a certain distance through the air and on their way form numerous pairs of ions which increase ionization. The doses determined by air ionization are, therefore, relatively too large for hard rays. The result in the tissue becomes too small, if this method of determining the dose is applied. All this helps to explain why the biological values measured with different dosimeters cannot correspond. In order to standardize the dosage problem it seems necessary to select an effect which runs parallel to the biological reaction, or an effect which is independent of the wave length of the radiation.

Dr. A. W. Erskine (Cedar Rapids, Iowa): To every one who is interested in the exact measurement of dosage, this contribution of Dr. Glasser and Dr. Meyer is extremely important, because it tends toward the simplification of an exceedingly complex problem. The method of determination of the half value layer, which was not explained by Dr. Glasser but which appeared in an earlier article, is extremely simple, and there is no reason why any of us, no matter how poorly we are equipped with measuring apparatus, should not express quality in terms of the half value layer as advocated by Dr. Glasser. All that is required is a ladder of aluminum, a strip of lead and an accurate timer. The work of Dr. Glasser apparently shows that, with the exception of very soft rays, the erythema dose, as measured by ionization, is a function of penetration. When I first received a letter from Dr. Glasser telling me of this work, I thought that possibly it might be a function of distribution: and in addition to excluding the effects of voltage and filter, which affect penetration or effective wave length, we might also exclude the effect of anode skin distance and size of fields, and say that no matter what the wave length, if the various physical factors are so arranged that we obtain identical distribution, the biological effect is the same. Unfortunately this is not true and the relation between the biological effect and the number of electrostatic units is dependent upon penetration only.

The second point I wish to mention is that

I am glad that Dr. Glasser advocates measuring the dose where it is received, that is, on the skin, because it is practical, it lessens the amount of calculation which is necessary and it lessens the chances of error, which are great enough at the best. Finally, this work, if it is corroborated, as I believe it will be, is a still further argument for the use of the half value layer method of expressing quality.

DR. A. U. DESJARDINS (Rochester, Minn.): Much has been said and written about the difference in the biologic effect of rays of different wave lengths. There is no question that, from a clinical standpoint, such a difference exists, but the difference is relatively slight in comparison with the effect of variation in quantity. Qualitative differences are of secondary importance. For instance, cases are encountered in which extreme therapeutic doses of rays generated at low or moderate voltage have been used and in which skin changes followed without any appreciable effect beneath the first centimeter. On the other hand, corresponding doses of rays generated at high voltage may produce extensive changes beneath the skin without any surface injury whatever. I have seen three or four cases of this kind where not only the skin but the subcutaneous tissues and underlying muscles were matted together in a solid mass of tissue plastered firmly to the underlying bone; the skin in these cases was leathery but otherwise intact and remained so. Changes such as these are never seen after irradiation at low or moderate voltages. Before any such alteration in the subcutaneous and muscle layers can be obtained, extreme ulceration of the skin is produced. Therefore, there is no question that the quality of the rays makes a certain difference, but that the quantity is at least twice as important as the quality.

DR. G. E. PFAHLER (Philadelphia): May I ask a question? Because I do not think we ought to close this thing without understanding it. I am sure we all appreciate the brilliant and excellent work of Dr. Glasser, but I would like to ask just what is meant by the half value dose? It may have been presented in his paper, but I did not get it. If I am the only one who failed to get it, I hope you will not waste any time on me. The next thing I would like to ask is how he determines what is the erythema dose, or, in other words, what is the erythema? I have been doing this clinical work for about twenty-eight years and I have not such a clear idea fixed in my mind of just what I would call an erythema dose, to lay it down on a curve such as we have presented on the board here. I favor exactness, but since the speakers have already referred to the fact that no two physicists seem to agree on the proper instrument to be used, and no two physicists agree on the measurements of the other fellow, I cannot see that we are getting quite as far as I thought we were going to get, four or five years ago, on these physical measurements. I am sorry, but that is my impression.

DR. A. MUTSCHELLER (New York): I think it is not too much to say that it is fortunate indeed that the curve shown by Dr. Glasser was found, considering that Dr. Wood determined two points which, by mere chance, were found to lie equally distant from the wave length axis, and therefore lead to the conclusion that the ionization effect of X-rays is proportionate to the biological reaction; thus another pitfall has been successfully avoided.

However, it has at all times seemed that there must be an error or a fallacy in the old theory, and I do not think that any one was fully and securely convinced that there is no selective biological action of X-rays, but up

to the present there was proof against and only evidence for it.

Some time ago I became interested in the effects of very low penetrating radiations and I found that with an average wave length of 0.4 Å. U. (45 K.V.) there is a surprisingly large absorption in the upper skin layers. If I recollect correctly, only about 20 per cent of the incident radiation reaches the subcutaneous tissues. But even figuring on that small transmission, it is necessary in order to obtain an erythema reaction, to administer considerably larger doses than those ordinarily producing an erythema with shorter wave length rays. My results, therefore, point out that two conditions are responsible for a decreased biological effect upon the skin of long wave length radiations. One is the very large absorption of the incident radiation in the skin before it reaches the sensitive tissues, this perhaps being partly responsible for the missing of this selective effect by Dr. Wood when he directly irradiated his mouse tumors; the other effect is clearly a diminished biological sensitivity or a different action when rays of a longer wave length than 0.3 Å. U. are applied.

Dr. Albert Bachem (Chicago): In answering one of the remarks of Dr. Pfahler I would like to say that, as far as relative measurements are concerned, the situation is not so hopeless as Dr. Pfahler suggests. In my paper of yesterday, I gave relative figures concerning the effect of hardness and skin sensitivity, and these figures agree perfectly with the figures which have been given by Glasser and by Gruhn. On the other hand, I agree with Dr. Pfahler that the quantitative determination of a proper unit has not yet been established, as long as the *R* of American physicists is not identical with that of the German Bureau of Standards. We all know the importance of this problem and I feel that it might be a good suggestion to have the Radiological Society get in touch with the Bureau of Standards in Washington to have them determine the proper *R* unit corresponding to the theoretical determination as it has been advanced by German authors. If this unit corresponds to the German unit, then I think we would be justified in accepting it. If it did not correspond, then I am quite sure that the German unit would have to be redetermined that we finally might come to an international unit.

Dr. Glasser (closing): I thank you very much for the interesting discussion, which brought forth a number of important points. To come to Dr. Erskine's remarks first, I might say that a certain corroboration of our results already exists. A French scientist, Dognon, recently published a discussion of biological experiments on *Ascaris* eggs, made with rays of different wave lengths. He used three radiations of a very soft, medium and moderately hard character, and also obtained the main effect on the biological specimen with the medium hard rays and less effect with both the softer and harder ones, when applying equal dosages. Dr. Wintz in his discussion also said that he found an effect very similar to ours, when comparing ionization in air and skin reaction.

Dr. Desjardins' remarks are identical with those made by others in connection with our work. Of course, it has been known or suspected for a long time that soft rays have a better biological effect than hard rays. When going over the experimental foundation of the work done along these lines it mostly can be seen, however, that such biological observations have not been properly connected to a well established radiation dose. Dr. Desjardins mentioned in his paper this morning that he uses the MacKee formula for the calculation of his dose, when using soft rays. I do not think that for the

present time any dosage formula will deliver comparable results, especially when using various radiation qualities. Biological observations compared to arithmetically computed doses certainly are not satisfactory.

For this reason we tried to determine first our dose according to the present state of affairs as exactly as possible. This leads me to the remarks of Dr. Pfahler. Two weeks ago, when making comparative measurements in Dr. Duane's laboratory, I saw there one of Dr. Pfahler's ionization chambers, which was restandardized. Since our dosage unit agrees with Dr. Duane's electrostatic unit within a few per cent, Dr. Pfahler also must have used practically the same dosage units as we do. This agreement seems to be rather satisfactory and shows that you can find two physicists who can agree upon something. On the other hand, there is unfortunately not yet an absolute agreement between the units used in Germany and those used in this country. The quality of the radiation, as measured, for instance, by the well known half value layer of Christen, has nothing to do directly with the quantity determination. The half value layer indicates the quality directly of the X-ray beam and does away with the inaccurate terms of spark gap or kilovoltage. Dr. Meyer many years ago devised a simple method to determine the quality by means of the half value layer; the method works very satisfactorily and is used for all our routine work.

As to the question of the erythema dose, I am really not qualified to answer this question of Dr. Pfahler's and I am sorry that Dr. Meyer cannot be here to explain this part of our work. I might say that the erythema doses are based on Dr. Meyer's work of the last twenty years. Last year in an article presented at the Cleveland meeting we reported how our average erythema doses are defined and how they are measured in physical units.[1]

Dr. Bachem's proposition that the Bureau of Standards should take up these standardization questions is very good. I might say, that a large amount of the work done by the Standardization Committee of this Society so far has been directed towards the same goal and we all hope that the Bureau of Standards in a few months will be in a position to take up the problem of the standardization of the roentgen dose.

DR. DESJARDINS (closing): I have no quarrel with the physicist, because I realize that much of the present development in medicine is due to the increasing application to medical problems of fundamental physics and chemistry. However, as Dr. Bovie said not long ago, physicists in general are trained to deal with fixed conditions, because it is only under such known conditions that they can express their results in mathematical terms. However, in dealing with biologic reactions the conditions are not fixed and cannot be, and this has much to do with the difficulty in applying physical data to biologic problems. The most important thing is for us to remember that we are physicians first, and that we must know and take into account the varying reacting powers of the body. Patients vary a great deal in this respect and, unless we know and understand these variations, therapeutic measures of any kind are not likely to produce the best results. So far as the skin is concerned, we must take into account differences of complexion, variations between different parts of the body in the susceptibility of the skin to radiation, et cetera. It is because these and many other points are not sufficiently borne in mind that many actual or fancied complications arise.

[1] Meyer, William H., and Glasser, Otto: Erythema doses in absolute units. RADIOLOGY. April, 1926, p. 320.

RADIO-ACTIVE SUBSTANCES: THEIR THERAPEUTIC USES AND APPLICATIONS

GASTRIC CARCINOMA TREATED BY RADIUM APPLICATION

By JOSEPH MUIR, M.D., New York City

CANCER of the stomach is the commonest form of malignancy, for although it affects men more frequently than women, both sexes are prone to suffer from it, and while its victims are usually of the expected "cancer age," that is, in the fifth and sixth decades especially, many cases are on record where young persons, and even children, have succumbed to it. The literature concerning gastric cancer —as might be expected in view of the facts just cited—is so vast that no one person would ever be able to entertain a reasonable hope of reading it all, and seemingly every possible means of treatment has been exhaustively discussed. Yet when we attempt to review that part of it which pertains to radium therapy, we discover with considerable surprise that almost nothing has ever been written about it, and it is only by the most diligent search that we can even unearth a few references to the application of this element to cancer in the stomach, occurring in general articles on the subject of radium therapy.

The reason for this, however, is simple enough. Cancer of the stomach, at present regarded as one of the most favorable neoplasms to submit to surgery, when seen before the disease is far advanced, is probably the most difficult and inaccessible to radium treatment. No doubt because of its prevalence, and the great anxiety of patients and their friends, repeated attempts to apply radium to gastric carcinoma have been made, but it is reasonable to suppose that so few of them have ever been even partially successful that those who made them saw no good in parading their failure and disappointment before the world. Be this as it may, the fact remains that to-day, when one seeks to compare the present methods of application with those employed in the earlier phases of radium therapy, he has great difficulty in even forming an idea of what these methods were, and therefore is more or less at a loss to find out why they failed, so meager is the evidence both for and against the use of radium in combating this particular lesion.

The vast improvement made in roentgenologic diagnosis of alimentary tract diseases, especially malignancy, has served during the past fifteen years to make surgery of the stomach far safer and more satisfactory than ever before. Three-quarters of the cancerous lesions found there are located at the pyloric end, and it is universally admitted that, given sufficiently early recognition, a cancer at the pylorus may in a large percentage of cases be completely removed by excision. The stomach's powers of regeneration seem to be very great even under adverse conditions, and although many patients do not come to operation until they are much debilitated and have become correspondingly poor risks for surgical interference, the general results in the operative treatment of gastric carcinoma have been so satisfactory that even those who were enthusiastic over the use of radium in other malignancies stood ready to cry "Hands off!" when it was suggested for use in this region.

Yet quite early in the history of radium therapy we find attempts being made to determine the applicability of this agent to lesions of the stomach, for in the *Bulletin* issued by the French Association for the Study of Cancer in 1909, we find a report of experiments performed upon dogs, for the purpose of observing the effects of the

rays of radium upon the gastric mucosa. A gastrostomy was done on the experimental animal and a tube containing 50 milligrams of radium bromide, screened with 0.5 mm. of silver, was inserted and left against the stomach wall for twenty-four hours. Immediately after the tube was withdrawn no effects could be noted. It was not, indeed, until a week had elapsed, that hyperemia and extravasation of blood began to be noticeable in the section of mucosa which had received the radium exposure. During the succeeding week it was evident that extensive destruction had taken place throughout the entire thickness of the mucosa, for where the direct contact with the radium applicator had occurred both the superficial epithelial cells and those of the underlying glands had been destroyed. Hyperplastic changes were in evidence in the connective tissue of both mucosa and submucosa, but in the more remote tissues where the action of the radium had not been so direct the cells seemed to be stimulated rather than injured. The entire effect, however, was confined to an area not over 3 centimeters in diameter, in the center of which the radium tube had been placed.

These findings did not encourage investigators to feel that radium was especially adapted for use in the stomach cavity. Though in France many branches of radium therapy made great strides, so that for certain lesions—cancer of the uterine cervix being a notable example—surgery was almost abandoned in favor of radium treatment, gastric cancer still continued to be referred to the surgeon, or, if found quite beyond hope of his aid, to have radium applied as a last desperate resort. That success did not crown these eleventh hour efforts is hardly a matter of surprise. Radium, in so far as this particular use of it was concerned, came to be regarded solely as a palliative measure, used merely to make the last days of the sufferer more tolerable for himself and those around him.

In the text-book published in 1921 by Béclère, Cottenot and Laborde, we are told that in certain cases radium radiation will bring about a diminution of pain and an apparent regression of the neoplastic mass, this lessening in the size of the tumor being no doubt due to a reduction in the volume of inflammatory tissue surrounding it. The effect, however, is only palliative and is incapable of retarding the progress of the disease. It may be obtained by applying over the epigastric region an apparatus containing from 100 to 150 milligrams of radium element, or its equivalent in millicuries of radium emanation, this being left in place for from 15 to 20 hours. The work done by Gaultier and Labey is also cited, these authors being apparently the first French radium workers who actually undertook to apply it to gastric carcinoma. Their patient was in such a debilitated condition when he came to operation that it was impossible to undertake resection of the pyloric end of the stomach where the neoplasm was situated. It was therefore decided to do the less dangerous gastro-enterostomy and to apply radium through the laparotomy incision, as a substitute for the second stage operation. The radium application was made under the direction of Dr. Wickham and Dr. Degrais, at that time generally recognized as the foremost radium therapists in France. A glass tube containing one centigram of pure radium sulphate, surrounded by a screen of one-tenth millimeter of lead, and enclosed in an outer covering of rubber, was attached to a silver wire so bent as to be readily passed through the operative wound, and to bring the radium applicator in direct contact with the neoplasm. At the same time a plaque 12 centimeters square, screened with 3 millimeters of lead, and containing 12 centigrams of radium sulphate, was placed upon the external surface of the abdomen, directly over the tumor, the location of which could be exactly designated by palpation. The laparotomy wound was kept

open from June 17, the day of operation, until September 8, and in the interval six radium applications were made, the system of cross-firing being followed up. The usual length of the exposure was from an hour and a half to two hours. September 8, the edges of the operative fistula were freshened and the opening sewed up; a month later the patient left the hospital and within three months his weight had risen from 48 kilograms at the time of the gastro-enterostomy to 63 kilograms, he was able to resume his occupation, and was to all appearances a well man.

The authors who presented this case felt that there was a reasonable doubt as to whether the excellent results obtained were due to the action of radium or to the rest which the gastro-enterostomy gave to the diseased pylorus. It was probably this doubt which made other French physicians slow to follow their example. At any rate very few did. Julien, of Nice, is cited by Béclère and his collaborators as having successfully opened the stomach and placed radium applicators in direct contact with inoperable malignant growths within the cavity, but I have been unable to find the original account of this procedure.

In this country and in England we find a few notices of attempts to give palliative treatment to inoperable gastric neoplasms by means of radium, but they are infrequent and widely scattered. In 1916 C. Everett Field published an article in which he declared that "we are not able to present satisfactory results in gastric carcinoma from the use of radium, although many have attempted to give treatment in various ways. Special applicators of silver and rubber, with handles suitable for introduction, have been used, but the inability definitely to locate the mass and give proper application is sufficient reason for the fact that there is but little literature. . . . Undoubtedly, the fear of producing radium burns and the consequent danger of perforation have deterred many from attempting treatment. Furthermore, the lack of suitable means of introducing under the field of vision an applicator containing radium of sufficient potency and maintaining it in proper position for an hour or more, have been deterrent features. . . . We hope that some device will be presented in the immediate future to give us the same possibility of application that is (now) afforded in the bladder. Einhorn, of New York, some time ago employed a gastric applicator, called the 'radiodiaphane,' which was simply a radium-tipped applicator, carrying a rubber tube and permitting gastric distention by means of a hand bulb. This instrument was used in numerous instances, but for the most part was reported as unsuccessful."

Shortly after this we find Pinch, of the Radium Institute, London, writing that in early cases of gastric carcinoma "surgical interference offers the best prospect of cure. . . . When the disease is so far advanced as to be inoperable, radium treatment may be tried, though the outlook is not promising." The methods used in applying radium to the stomach at the institution of which Pinch was the director were as follows:

(1) If the disease is fairly localized, and in a position which readily permits the necessary manipulations, the abdomen should be opened, and one or more radium tubes (the strength and number of the same bearing relation to the size of the growth), screened with 1 mm. of silver, should be buried at equal intervals throughout the mass, an exposure of twenty-four hours' duration being given. At the end of that time the tubes are withdrawn and the laparotomy wound completely closed. He adds that this procedure has been adopted with some success in America, and in the few cases already reported some distinctly encouraging results have been recorded.

(2) External radiation with numerous powerful heavily screened applicators

should be adopted in those cases where the first method is either inadvisable or impracticable. It is never more than palliative, but will often do much to relieve the epigastric pain and arrest the rate of growth, and if general peritoneal infection be present, with commencing ascites, it will frequently greatly retard the development of ascitic fluid; but this is the utmost that can be expected.

Elsewhere we read that Pinch at one time employed a third method—termed *radiation of the stomach from the interior.* In this method an emanation tube of from 100 to 200 mgrs. activity was prepared and enclosed in a silver capsule about two centimeters in length, its wall being one millimeter in thickness. This capsule was attached by means of a screw stopper to about three feet of silk thread. It was then introduced by the finger into the upper part of the esophagus, and swallowed by the patient, its passage down the esophagus being expedited by the ingestion of some thick porridge or gruel. The progress of the tube should be noted by means of an X-ray screen until the tube has reached the stomach, and its position then charted. The tube was allowed to remain in the stomach, its site being changed from time to time if necessary by a slight traction on the silk thread. A total exposure of from 24 to 36 hours was given, and the tube then withdrawn. Pinch found that this procedure was most effective when the gastric mucosa was badly ulcerated, so that the patient suffered from hematemesis or melena, for its effect upon hemorrhage was often very beneficial.

Some ten years ago, in the first report on radium work given out by the Memorial Hospital, New York, the late Henry H. Janeway commented very favorably on the treatment of gastric cancer with radium. At that institution it had been used internally in connection with a gastro-enterostomy, and by external application for palliative effects. He remarked that "cancer of the stomach offers a tempting field for the use of radium," for even under favorable conditions gastrectomy involves far more risk than posterior gastro-enterostomy, and he felt that it had become an important question whether the combination of radium treatment with posterior gastro-enterostomy, performed under local anesthesia, was not to be preferred in all but those cases peculiarly favorable for pylorectomy. Three patients whom he had treated by applications of tubes containing radium emanation through the same abdominal incision which had been made for the performance of a preceding gastro-enterostomy, had been greatly improved, though it was "of course doubtful how much the radium exposures have had to do with the improvement apart from the gastro-enterostomy." Advanced cases treated merely by external applications had in general received little benefit, though one case where there was considerable temporary relief from pain is recorded. It is noticeable that in the next radium report from the Memorial Hospital, there is absolutely no mention of treating cancer of the stomach with radium, merely the statement: "Operable growths of the stomach . . . are still excised."

The only recent literature regarding radium treatment of gastric malignancy appears to be that detailing the work of Menees, of Detroit. Two years ago he published a description of an apparatus by which he believed radium could be accurately applied to an intragastric lesion without resort to surgical opening of the abdominal wall. The radium container was attached to a fine spiral spring; this was passed through a small rubber tube into an attached rubber bag. A sphygmomanometer bulb was attached to the other end of the tube, and the rubber bag with the contained radium swallowed by the patient in the same manner as is done with the duodenal tube.

Before swallowing the bag and radium container the patient ingests a barium meal.

When the bag reaches the stomach it is inflated and under careful fluoroscope observation the progress of the radium applicator is noted until it reaches the portion of the stomach which it is desired to treat. In a later communication Menees described improvements in his original plan, which enabled him to move the radium container about in the stomach without loss of the air in the bag. The general plan of treatment, however, remained the same. The radium was lightly filtered (0.5 mm. of silver) and the treatment divided into short sessions of from one to three hours daily, continued until all the accessible surface of the tumor had been irradiated. The usual dosage was 50 milligrams. The author's conclusions are that by the use of this apparatus a greater dosage can be applied to the surface of a gastric carcinoma with less general irradiation of the upper abdomen, and can be pushed to a caustic effect with superficial necrosis. From this increased irradiation greater palliative effects can be obtained in slowing the rate of growth, checking hemorrhage, relieving pain and preventing obstruction by destroying the surface of the tumor in the narrow portions of the stomach. He admits, however, that the method is only palliative, and complete regression can be hoped for in no case save "highly cellular anaplastic growths which are not too extensive."

A consideration of this retrospect of the application of radium to malignancy of the stomach throws one or two factors into strong prominence. Chief among these is the total inadequacy of external applications, and second, the lack of success which has crowned all the efforts to put radium into the stomach without previous surgical intervention. In all cases where gastro-enterostomy has been done in conjunction with radium therapy there appears to be doubt as to whether the ensuing good results would not have been attained by the surgical intervention, even if no radium had been used. It is likely that in those cases where the site of the malignancy is at the pylorus we must await the collection of a vast amount of clinical data before this doubt can be cleared up. There are as yet too few cases on record where radium has been used in conjunction with gastro-enterostomy to permit us to compare them with those where the passage of the stomach content was "short-circuited" without any subsequent radium treatment.

But that the radium results can be greatly bettered by the use of improved methods in making intragastric applications there can be no question. In the stomach, as in any other hollow viscus lined with epithelium, the caustic action of the beta rays of radium is extremely injurious, not alone to the healthy tissue, but indirectly through its action on the malignant cells, for by causing necrosis and subsequent sloughing, any good effects from the destruction of the cancerous growth will be quickly nullified. The first requisite, then, for successful intragastric radiation is an applicator so fashioned as to prevent any kind of radiation reaching the healthy portion of the mucosa, while at the same time it permits only therapeutic rays to be brought to bear upon the diseased area, excluding the caustic rays which induce necrosis. It is evident that of all the radium therapists whose work we have considered in the preceding paragraph, Gaultier and Labey, nearly twenty years ago, came the nearest to attaining these conditions. They applied radium in screened tubes through a laparotomy opening, burying the tubes directly in the neoplasm and withdrawing them after a definite period of radiation. The chief drawback to this procedure would appear, from their account, to have been the fact that the repeated applications at that time deemed necessary, obliged them to keep the laparotomy wound open for more than three months, so that another surgical intervention was required to close it.

The implantation method, using screened

removable containers of sufficient strength to make but one application necessary, retains all the good features of this earlier attempt and does away with all its drawbacks. In advanced carcinoma of the pyloric end of the stomach a gastro-enterostomy should be done to afford relief from irritation of the diseased area, and the surgical opening thus made serves to permit the implantation to be made under direct vision. Platinum radon seeds having as high a content as 5 millicuries can be safely implanted in sufficient number to permit of adequate radiation of the whole neoplasm, according to its dimensions. The abdominal incision need be kept open only during the required period of radiation—four days—after which the seeds are all withdrawn and the wound closed in the usual manner. Better still, the same dosage may be delivered by using 3-millicurie seeds for a radiation period of ten days.

The results in the relatively few cases which have been handled in this way have far exceeded the most sanguine expectations. The work, however, is too recent to permit the drawing of any final conclusions. In a number of cases, wholly inoperable when first seen, the neoplasm has disappeared completely after radon implantation, the patient has regained health and strength, and returned to practically normal diet and mode of life. Whether these results will be permanent, time alone will show; one thing is certain, the lives of these unfortunates have been prolonged under conditions which make the treatment—from the patient's point of view—well worth while. In many cases operated upon, though life is prolonged, the suffering and general overthrow of the patient's *morale* make it a somewhat doubtful blessing, as the conditions are hardly those tending to make prolongation of life desirable. There certainly appears to be adequate ground for claiming that radium applied by the implantation method has done more for advanced gastric carcinoma than surgery has ever been able to do, and that the prospects for the future are such as to give the radium therapist every reason for believing that his results will prove as permanent as those of any curative method heretofore undertaken.

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LOCALIZATION OF FOREIGN BODIES IN OR ABOUT THE EYE[1]

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WHENEVER an eye is injured by a foreign body, it immediately becomes of vital importance to determine (1) whether the globe was penetrated by the body, and (2) whether the foreign body remained within the globe or passed through it. The proper management of such injuries depends upon the early and accurate determination of these points. Sometimes examination with the ophthalmoscope will give the necessary information, but usually a penetrating wound of the globe will so cloud the transparent fluids and structures of the eye that ophthalmoscopic examination is not satisfactory. Therefore, following the discovery of the X-ray, the advantages of determining the presence of a foreign body by radiography, and its accurate localization, were quickly recognized, and the work in this field was one of the earliest developments in clinical radiology.

The first recorded localization of a foreign body in the eye is said to have been the one made by Dr. Francis H. Williams and Dr. Charles H. Williams, of Boston, on June 5, 1896, reported by Dr. Charles H. Williams, in the *Boston Medical and Surgical Journal* of Aug. 13, 1896, the X-ray work being done at the Rogers Laboratory of Physics of the Massachusetts Institute of Technology.

Dr. W. M. Sweet, of Philadelphia, reported localization by his method in the *Archives of Ophthalmology* of November 27, 1898. Dr. Charles F. Bowen, of Columbus, Ohio, also reported his method of localization about the same time.

Since the perfection of localization technic, ophthalmologists have been placed in a position of decided advantage in handling foreign body injuries of the eye. The ability to determine definitely the location of the foreign body, its size, shape and, within limits, its nature, permits the proper treatment of such injuries to be given early and has conserved the vision of many eyes which would, otherwise, have been lost.

Among the writers on this subject, from the radiologic standpoint, during recent years, may be mentioned the following:

John S. Derr, in the *American Journal of Roentgenology*, August, 1916, emphasized the value of X-ray in determining the presence of foreign bodies and the ability to recognize very small foreign bodies. He described the old Sweet apparatus and reported sixteen cases of localization.

James G. Van Zwaluwenburg, in the *American Journal of Roentgenology*, for October, 1917, emphasized the necessity of fixation of the head and globe, and discussed various sources of error and their avoidance.

Ancil Martin and W. W. Watkins, in *Southwestern Medicine*, for November, 1919, discussed the value of radiography, and the varying density of different substances encountered as foreign bodies, reporting twelve selected cases.

M. B. Titterington, in the *Journal of Radiology*, for January, 1920, described in detail methods with the Sweet-Bowen localizer, and also with the improved Sweet localizer. Emphasis was laid on the necessity for complete fixation of the globe. Films should be checked against each other, and if there is a variation, a new set should be made.

James M. Patton, in the *Journal of the American Medical Association*, Sept. 23, 1922, writing on the "Localization and Extraction of Intra-ocular Foreign Bodies," emphasized that in every eye injury the possibility of intra-ocular foreign body should

[1]Read before the Radiological Society of North America, at Milwaukee, Nov. 29–Dec. 4, 1926.

be considered. The eye seems to tolerate copper or brass more kindly than other non-magnetic substances. The X-ray is the most valuable aid in diagnosing and locating foreign bodies in the eye.

of the injury. When both eyes are injured and photophobia is present, it may be impossible to secure fixation of vision on the mirror. Even when only one eye is injured, fixation of vision with the good eye may not

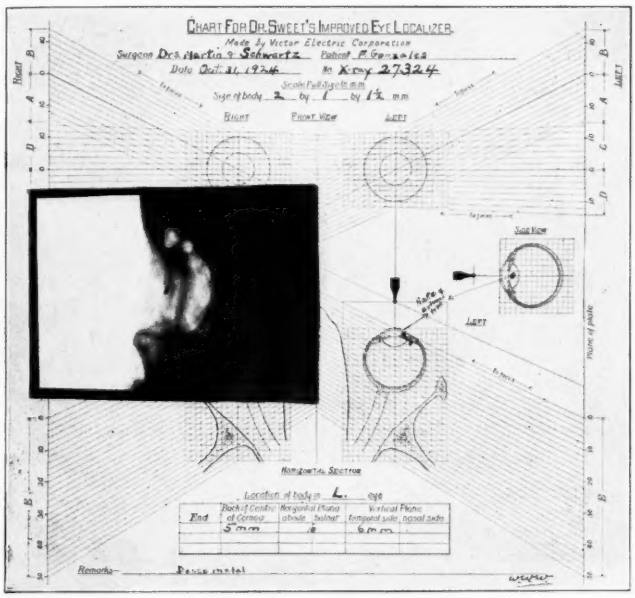

Fig. 1. F. G., injured Oct. 9, 1924, examined Oct. 30; complained of loss of vision and photophobia; no pain; cornea clear, without evidence of wound. Anterior chamber normal in depth; lens clear; in the irido-corneal angle of temporal side, slight bulging of iris and inflammatory changes; fundus normal. X-ray showed a totally dense foreign body 2x1x1½ mm., in ciliary region, temporal side, 5 mm. back of cornea, 6 mm. to temporal side and in vertical plane. This corresponded to the bulging mentioned. On Nov. 9, foreign body extracted by giant magnet, anterior route; body became entangled in iris and iridectomy was done, foreign body being drawn through this opening. On Nov. 28, vision was 15/70 plus and eye quiet. On Feb. 10, 1925, vision was 15/50. *Comment.*—History indicated that eye was struck by rock. There was no visible wound of entrance when examined by ophthalmologist, yet there was a fairly large foreign body, which proved to be iron. Illustrates the necessity for X-ray examination in *every* injury to the eye.

The technic of localization with the Sweet localizer has been described by several writers, especially by Titterington, and will not be repeated here. We wish to emphasize, along with the writers mentioned, the necessity for scrupulous exactness in technic. In many cases, however, exact technic becomes impossible on account of the nature

prevent nystagmus or involuntary movement in the injured eye. When fluid has been lost from the eye, the cornea may collapse or the globe shrink so that the charted measurements become inaccurate for the eye under examination. The globe may be displaced by hemorrhage into the orbit, by edema around the eye, or bony injuries

to the orbit, so that the charted localizations are uncertain.

These and many other factors make localization difficult and uncertain in some cases. In spite of these sources of error, however, localization by the Sweet apparatus is remarkably accurate and can usually be taken as a reliable guide in handling foreign bodies in or about the eye. Even in those cases where there are multiple small foreign bodies, as after a blast or other explosion into the face, usually the particles within the globe area can be selected and localized with respect to the eye. In such cases, the errors are such as are inherent in the nature of the foreign particles, since tiny particles of hard dirt or some kinds of rock cast hardly any shadow and are sometimes not visible on the radiograph.

In the analysis of any large group of cases, the value of localization soon becomes apparent, and certain kinds of injury be-

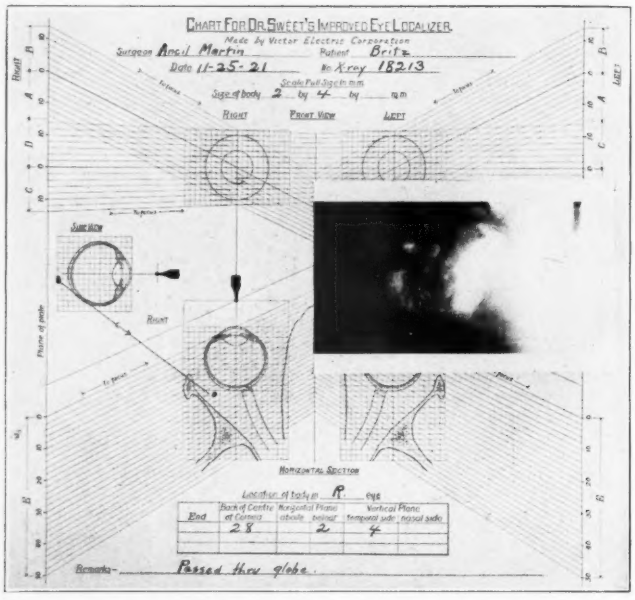

Fig. 2. J. B., injured April 2, 1917. Right eye became red and painful, with objects blurred. On April 3 there was marked ciliary injection, with clear cornea and lens, though vitreous was filled with blood clots. There was wound of bulbar conjunctiva and underlying sclera 6 mm. to temporal side of limbus in horizontal plane. Application of magnet gave no result. X-ray on April 3, by Dr. W. H. Sargent, showed the foreign particle posterior to the globe, in the same location as subsequently found by us. No further attempt at removal. On July 20, eye was quiet, no redness, lens clear, large mass of floating shreds in vitreous. Vision 7/200. On Oct. 25, 1921, X-ray showed foreign body, measuring 4x2x2 mm., lying posterior to the globe, 28 mm. back of cornea, 2 mm. below horizontal plane and 4 mm. to temporal side of vertical plane. Eye was quiet; vision—light perception. *Comment.*—Illustrates value of localization before attempting extraction. Magnet in this case did no harm, but in some cases magnetic pull might be harmful. After ascertaining the location of this fragment, it was plain that extraction was not indicated.

come impressive by their recurrence. In 500 consecutive examinations of eyes for suspected foreign body, made by us from Jan. 1, 1918, to July 1, 1926, we have localized foreign bodies within or about the eye in 146 patients.

ulation showing the interesting features of the 146 cases upon whom localization was necessary. Supplementary to this, we wish to outline briefly several classes of injury in which radiography is especially valuable, with one or two typical illustrative cases in

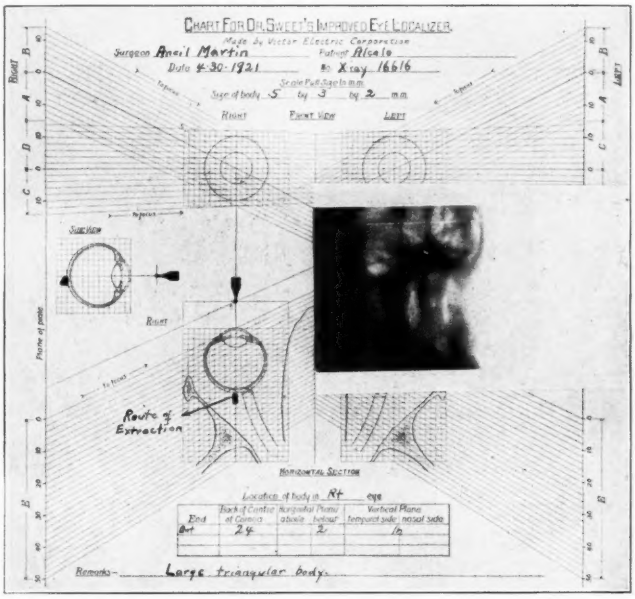

Fig. 3. O. A., injured April 28, 1921. Large central corneal wound in right eye, with swollen and flocculent lens; pupil irregular in size; tension minus. X-ray showed a large foreign body, 5x2x3 mm. in size, located just posterior to the globe, in the vertical plane, and just below the horizontal plane, having the density of heavy metal. Wound of exit evidently between macular region and nerve disc and may have injured both. Through a canthotomy opening into orbit on temporal side, foreign body was extracted with magnet. Patient discharged May 17 with eye quiet, tension normal, traumatic cataract. Light perception present. *Comment.*—Accurate localization of this foreign body permitted its removal without further injury to the eye.

The large number of cases giving negative results illustrate how important this examination is regarded by the ophthalmologists for whom we work. The eye specialists of Arizona who handle industrial work have every eye injury radiographed, there being about three reported negative as to foreign body to one in which we need to localize. There is submitted herewith a tab-

each class. Other instances of each of these groups will be found in the tabulation.

1. In some injuries there is demonstrable intra-ocular damage but foreign body is not found in or about the globe.

Example:—J. T., on Oct. 25, 1925, was breaking rock with a hammer when something flew into his left eye. Examination in afternoon of same day showed incised

wound of lower lid; also an incised wound extending from the limbus margin into the cornea and into the anterior chamber; through this opening the iris had prolapsed. X-ray (our No. 27,261) showed no shadow of foreign body localizing within the globe area. Prolapsed iris was amputated, and recovery was satisfactory, vision on November 10 being 15/15 with correction.

2. With surprising frequency, cases present in which very careful search has failed to reveal any wound of entrance, and yet foreign body is localized in the globe by X-ray. This is more likely to happen when the injury is old, but may occur even when the injury is quite recent.

Example (Fig. 1):—On Oct. 9, 1924, while the patient was breaking rock with a hammer, a foreign body, supposedly rock, struck his left eye. When examined in Phoenix on October 30, there was lachrymation and photophobia, but no pain; complained of loss of vision. Cornea was clear and there was no visible wound of entrance; anterior chamber was normal in depth, with fine pin-points of uveal pigment visible; balance of lens clear. In the irido-corneal angle of the temporal side there

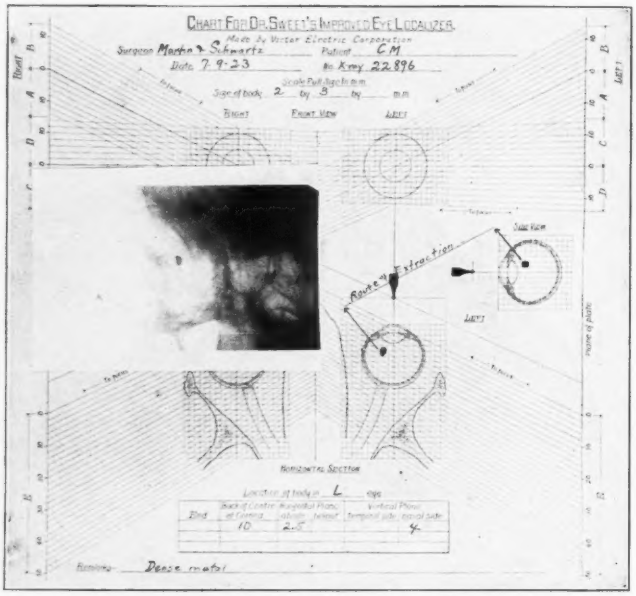

Fig. 4. C. M., injured July 3, 1923. Examination of left eye showed perforating wound of inferior portion of left cornea, with prolapsed iris. Hemorrhage into anterior chamber and pupil displaced downward. Large clot in vitreous. X-ray showed a triangular shaped foreign body 4x4x3 mm. in vitreous chamber, 12 mm. back of center of cornea, 4 mm. above horizontal, and 3 mm. to nasal side of vertical planes. Density of heavy metal. Scleral opening was made 6 mm. posterior to the limbus in the superior nasal quadrant, L-shaped, and foreign body extracted by giant magnet. Inflammatory disturbance gradually subsided and eye became quiet but with light perception only. *Comment.*—Localization, by showing the size, shape, and location of this particle, guided surgeon in making posterior extraction through a new opening, thereby avoiding further intra-ocular injury.

was a slight bulging of iris and evidence of inflammatory changes. Fundus was normal.

X-ray showed foreign body (No. 27,324) $2 \times 1 \times 1\frac{1}{2}$ mm., of total density (metal) localizing in the ciliary area of the temporal side, in the spot corresponding with the bulging mentioned.

This was extracted on November 9, by giant magnet, anterior route. Foreign body became entangled in iris and iridectomy was done, the particle being drawn through this opening. On Feb. 10, 1925, vision was 15/50.

3. The foreign body may have passed through the globe, and the intra-ocular structures be so disturbed that opthalmoscopic examination is of little value. In such cases, localization may prevent needless and sometimes injurious attempts to find the body or remove it.

Example (Fig. 2):—J. B., on April 2, 1917, while at work as boiler-maker, was struck in the right eye by a piece of chipping. On April 3, there was marked ciliary injection, with clear cornea and lens, though vitreous was filled with blood clots. There was wound of bulbar conjunctiva and the underlying sclera, 6 mm. to temporal side of limbus in horizontal plane. Application of magnet did not bring foreign body into view, and localization by Dr. William H. Sargent showed the foreign body to be posterior to the globe in the same location subsequently found by us. No further attempt at removal was made and on July 20 eye was quiet and vision 7/200.

On Oct. 25, 1921, he was re-examined by us (18,213), localizing foreign body, $4 \times 2 \times 2$ mm., lying posterior to the globe. Eye was quiet with light perception. It is probable that application of magnet did no harm in this case, but after localization it was evident that removal was not indicated and its attempt would be futile.

Example (Fig. 3):—O. A., on Oct. 28, 1921, while using cold chisel on steel, was struck in right eye by flying particle. Corneal wound central and very large; lens flocculent and swollen; pupil irregular in size; tension minus.

X-ray (16,616) showed a large foreign body, $5 \times 2 \times 3$ mm., located just posterior to the globe in the vertical, and just below the horizontal, plane.

This foreign body having evidently passed through the globe, a canthotomy opening was made in the temporal margin of the orbit and foreign body pulled through this with magnet. Patient was discharged on May 17, with eye quiet, traumatic cataract, but with light perception.

4. In cases of non-magnetic foreign bodies, like copper or rock, it is very essential to know whether there are intra-ocular particles, as the indications for enucleation or conservative treatment may depend on this information.

Example:—C. C., miner, age 18, struck a blasting cap with pick on Dec. 22, 1925, receiving wound in right eye. Examined on December 26. Lens opaque; wound in center of cornea, with wound through lens. Minute particles of copper in depths of corneal tissue.

X-ray (33,072) showed a foreign body about 2 mm. square in the vitreous chamber; particle was too dense for rock and was probably copper.

Eye continued to be inflamed and, with knowledge that it contained copper, enucleation was done on Jan. 26, 1926. An irregular piece of copper was found in the vitreous surrounded by a green-stained focus of pus.

5. Where multiple foreign bodies have been blown into or about the eye, as after a blast, the treatment is usually guided by the presence or absence of intra-ocular particles in one or both eyes.

Example:—T. J., on July 9, 1923, picked into missed hole and received blast in face. When seen on July 12 he had extensive laceration of each cornea and numerous for-

eign bodies in the substance of the cornea. Traumatic cataract in each eye.

(*Note:* Left eye was apparently the least injured, but the presence or absence of foreign bodies within the globe would determine the treatment.)

Radiographs of each eye area (22,922) showed numerous foreign bodies about each orbit. Two particles definitely localized within the vitreous chamber of the right eye, but no particles were localized within the left globe (5a).

Right eye was subsequently enucleated, chiefly to avoid sympathetic irritation of the left eye. Traumatic cataract was removed from the left eye, the visual impairment in this eye being due to corneal scars which limited vision to the perception of large objects nearby.

6. The determination of the exact size, location, and shape of foreign bodies by X-ray frequently furnishes the necessary indication for the route of extraction of magnetic foreign bodies, or suggests the possibility of extraction by forceps of non-magnetic bodies. This improvement in technic

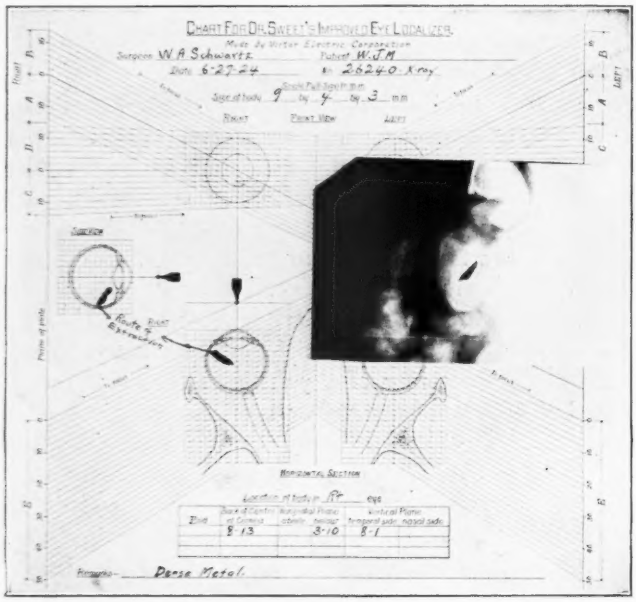

Fig. 5. W. J. M., injured June 22, 1924. Examination of right eye on June 26 showed perforationg wound of sclera on nasal side about 1½ mm. from limbus. Anterior chamber normal; lens slightly cloudy; hemorrhage into vitreous; fundus not visible; vision—fingers at 4 feet. X-ray showed large foreign body, measuring 9x2x4 mm., in vitreous chamber, one extremity close to sclera of temporal side. On June 26 incision was made through sclera, over end of foreign body; it was found to be non-magnetic and was removed with forceps, proving to be a particle of brass. On August 14 patient was discharged; eye was quiet; no changes in cornea or lens; massive opacities in vitreous; upper part of fundus could be indistinctly seen; vision—hand movements at one foot. *Comment.*—Localization of this fragment, so that scleral incision could be made over one end of it, made possible its removal without further trauma. It is very unusual to remove so large a non-magnetic foreign body from the globe and still preserve any vision, or even to preserve the eye for cosmetic value.

has permitted the conservation of the eye or the vision in many instances where, without this guidance, the eye would have been totally lost.

Example (Fig. 4):—C. M., miner, age 41. On July 3, 1923, while holding bar for driller, something flew into left eye. When examined four days later, there was a perforating wound of inferior portion of left cornea, with prolapsed iris, hemorrhage into anterior chamber, and large clot in the vitreous.

X-ray (22,896) showed a large foreign body, 4 × 3 mm., in the vitreous chamber, above and to nasal side of lens.

In view of the location and size of the particle, a new scleral opening was made, 6 mm. posterior to the limbus in the superior nasal quadrant, and foreign body was drawn through this with magnet. The inflammatory disturbance gradually subsided and eye became quiet, with light perception present.

Example (Fig. 5):—W. J. M. On June 22, 1924, while chipping on a brass plug, something struck him in the right eye. Ex-

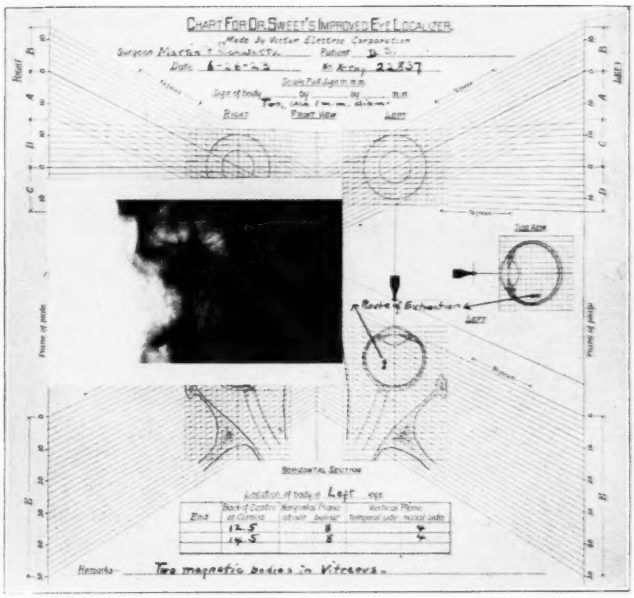

Fig. 6. D. S., aged 12, injured June 20, 1923. Examination of left eye four days later showed wound at upper margin of cornea; lens swollen and opaque; anterior chamber shallow. X-ray showed two foreign bodies of about the same size and density, in the vitreous chamber, 13 and 15 mm. back of cornea, 8 mm. below horizontal and 4 mm. to nasal side of vertical plane. They were of the density of heavy metal and lay close together without visible union between them. The two particles were extracted by the posterior route, through a new scleral opening; they came together, but dropped apart when magnet's attraction was removed. *Comment.*—Two magnetic foreign bodies in the same eye is an unusual finding, but is another illustration of the necessity for X-ray localization. The indications for extraction by the posterior route were also furnished by the X-ray findings.

amined June 26; perforating wound of sclera on nasal side about 1½ mm. from limbus. Anterior chamber normal; lens cloudy; hemorrhage into vitreous; fundus not visible; vision, fingers at four feet.

a piece of brass, measuring 9 × 4 × 2 mm. Eye quieted down; on August 14 patient was discharged with vision of hand movements at one foot; lens and cornea were clear, the loss in vision being due to vit-

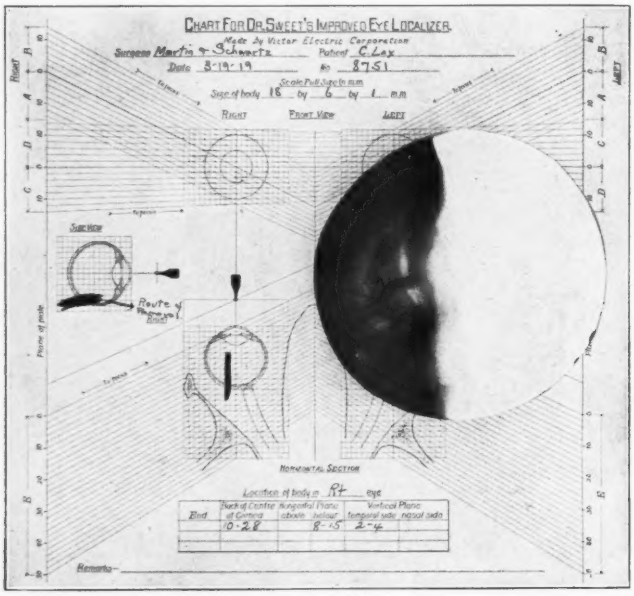

Fig. 7. C. L., injured in right eye March 17, 1919. Incised wound of lower lid, with soft tissues edematous; cornea and anterior chamber uninjured; lens clear; fundus clear in upper portion; large dark mass in floor of vitreous; vision in lower field only. X-ray showed a very large, thin foreign body localizing part way within the vitreous chamber and protruding posteriorly beyond the globe. By giant magnet, this was drawn back through wound of entrance. On April 7 he was discharged with eye of good appearance and with vision of fingers at three feet. *Comment.*—It is extraordinary to have so large a foreign body penetrate the globe and yet to preserve the globe after its removal. It was very thin and its shape and position, as shown by the localization, enabled the surgeon to withdraw it with the magnet with a minimum of trauma.

X-ray (26,240) shows a large dense foreign body, measuring 9 × 2 mm., in the vitreous, with one end close to the inferior temporal scleral wall.

With this guidance, an incision was made through the sclera over the end of the foreign body. Application of magnet proved it to be non-magnetic, and it was grasped with forceps and extracted. It proved to be

reous opacities. On September 9, there was noticeable improvement in vision.

7. When foreign bodies change position, either unassisted, or after application of magnet, it is frequently very desirable to determine this by re-localization.

Example (*a*):—P. M., miner, age 41. On Jan. 30, 1924, while working on cement floor, was struck by flying particle in left

eye. Examination showed a linear wound in nasal limbus, 2 mm. in length. Eye was irritable, lens opaque and photophobia present.

X-ray (24,616) showed a foreign body 2×1 mm., in the vitreous chamber against the posterior scleral wall. Density was that of metal.

Magnet was applied on February 1, which produced pain; foreign body did not appear in the anterior chamber, so that it became desirable to know whether it was dislodged. Re-examination showed the foreign body had been drawn directly forward and was now at the lower internal angle of lens. It was then pulled through the suspensory ligament into the anterior chamber and extracted through wound of entrance.

Example (*b*):—Interesting, but of less practical importance, is an instance of a mobile non-magnetic foreign body. Patient was struck in right eye March 15, 1925, by piece of rock. First examining physician said that he could see it in the anterior chamber. Ophthalmologist could not see it, and X-ray localized it in the posterior chamber, on the nasal side, it apparently having fallen through the pupil into the posterior chamber. On June 15, X-ray examination showed the particle to be in the anterior chamber on the temporal side.

Being a small foreign body and non-magnetic, and the eye being quiet with good vision, no attempt at extraction was made.

8. It is frequently possible to give a fairly reliable opinion as to whether a foreign body is metal or rock. For example, in the case described under Example (*a*), above, in which the patient was chipping on cement, from the density of particle it could almost certainly be placed in the class of heavy metals.

9. Cases of more than one magnetic foreign body are encountered. It is possible to extract one of these and leave others, if localization is not used.

Example (*a*):—M. I. was struck in right eye by piece of flying steel on Sept. 27, 1925. One piece of steel was removed by physician in Nacozari, Mexico. Examination in Phoenix (Oct. 23, 1925) showed a small particle in the anterior portion of lens; this was removed by giant magnet.

Example (*b*) (Fig. 6):—D. S., on June 20, 1923, while chiseling out a rivet, felt something strike him in left eye. There was a single wound at upper margin of cornea, with lens swollen and opaque; anterior chamber shallow.

X-ray (22,837) showed two foreign particles, about the same size, one directly behind the other, in the lower portion of vitreous.

New opening was made in the sclera in the inferior temporal quadrant, and magnet applied. Both particles came out together.

10. Extraordinarily large foreign bodies can frequently be removed without additional trauma, when the size, shape, and best route for extraction are indicated by X-ray.

Example (Fig. 7):—Patient was struck in right eye by piece from head of bolt on March 17, 1919. Cornea, lens, and anterior chamber not injured. Injury to floor of vitreous. Very large, thin foreign body, more than half an inch long and quarter of an inch wide, shown projecting into the floor of he vitreous. By pulling directly back with the magnet, it was removed without additional trauma, and with preservation of the globe and partial vision.

In summarizing this review of our work with foreign bodies in the eye, we would conclude that accurate localization of such particles is not only desirable, as so conservatively stated in most papers on this subject, but is so necessary to the intelligent management of most injuries of this type that the procedure cannot safely be omitted in any foreign body injury to the eye.

TABULATION OF FOREIGN BODY LOCALIZATIONS IN THE EYE

Ser. No.	Date and X-ray No.	History and Injury	Localization	Treatment and Result
1	1-11-18 (5,230)	Oper. mch. drill; left eye wound, lower cornea.	F. b. 4x1 mm. in vitreous.	Not removed; vision permanently lost. M. and S.
2	4-3-18 (6,251)	Injury month old from striking drill with hammer.	F. b. in vitreous.	Magnet extraction of flake 1x½ mm. in diam. Vision 15/50; will grow less. M. and S.
3	8-13-18 (7,288)	Chip from mch. drill in L. eye; wound temporal limbus.	Large f. b. in vitreous.	Magnet extraction; hypopyon; enucleation. M. and S.
4	10-1-18 (7,557)	"Dust" fell in L. eye; incised wound inf. nasal limbus.	F. b. in vit.; density of metal.	Magnet extraction, ant. route; iridectomy; L. P. only account traumatic cataract. M. and S.
5	10-3-18 (7,586)	Hammering pipe; small perforating wound of cornea.	F. b. below and to temp. side of globe.	Not removed; dense lens opacity; vision 6/60. Evidently passed through eye. D. F. H.
6	10-10-18 (7,656)	Chiseling; struck L. eye; wound to nasal side of cornea.	F. b. 3x2 mm. in vitreous.	Magnet extraction through wound of entrance; infection; enucleation. M. and S.
7	10-11-18 (7,697)	Using drill; rock in eye 9 days before examination.	F. b. 3x2 mm., apparently in the vitreous.	Panophthalmitis; enucleation. Body in vitreous. D. F. H.
8	11-11-18 (7,944)	No record obtainable.	In vitreous to temp. side against scleral wall.	No record obtainable. R. R. B.
9	11-23-18 (7,998)	Struck on side of head; no recent eye injury; blind in R. eye.	Large f. b. 2x5 mm. behind and below globe.	No treatment; evidently old injury as shown by intra-ocular changes. M. and S.
10	1-10-19 (8,247)	Hammering, 28 days before; struck in R. eye; no def. scar of entrance.	F. b. 1x1x1½ mm. behind, to nasal side of lens.	Magnet removal ant. route; lens opacity; vision 15/40 with correction. M. and S.
11	1-20-19 (8,302)	Dyn. cap explosion; perfor. wound of cornea and lens.	Small f. b. 1x1 mm. far back in vit.	Enucleation 4 days after injury; copper found, with pus focus surrounding. M. and S.
12	2-12-19 (8,494)	Injured 7-3-18; drill; no wound of globe seen; vis. now failing.	F. b. 2x1x1 mm. in vitreous, to temp. side.	Magnet removal post. route; vision 15/20 with correction on 2/25. M. and S.
13	2-18-19 (8,534)	Corneal injury by f. b. Lateral film showed shadow over orbit.	F. b. shown by localization to be external to globe.	Corneal ulcer healed; eye became quiet. F. b. not molested. M. and S.
14	2-28-19 (8,598)	Blasting cap injury to both eyes; only R. has vision.	F. b. in R. vit. L. eye not exam.	L. eye enucleated; R. eye has tubular vision; prognosis uncertain account f. b. in it. M. and S.
15	2-28-19 (8,599)	Inj. 12-9-18 by cap explosion; no visible wound of entrance.	F. b. in vit.; movable; varies position.	Not removed; eye quieted; vision 15/100 when last seen. M. and S.

TABULATION OF FOREIGN BODY LOCALIZATIONS IN THE EYE—*Continued*

Ser. No.	Date and X-ray No.	History and Injury	Localization	Treatment and Result
16	3-19-19 (8,751)	Piece from head of bolt struck R. eye, lower edge of sclera.	Large thin f. b. partly through floor of vitreous.	Magnet extraction; eye of good appearance; vision L. P. only. M. and S.
17	4-8-19 (8,887)	Piece of rock in eye 2 mos. before; no vision; wound sup.-int. quad.	Small f. b. of low density in vit.	Other eye was irritable and enucleation was performed; rock found. M. and S.
18	5-5-19 (9,302)	Inj. 3-3-19; drilling; R. eye inj. Eye painful and no vision on 5-5-19.	F. b. (rock?) to temp. side of eye; none within eye.	By June 30, eye was quiet but cornea was cloudy and little vision; old injury. M. and S.
19	6-12-19 (9,469)	Old inj. (in 1917); recent injury left no visible signs in eye.	Very small f. b. in vitreous.	Intra-ocular evidence of old injury; f. b. not molested; of medico-legal interest. M. and S.
20	6-13-19 (9,485)	Inj. 2 yrs. before while digging; corneal scar; intra-ocular changes.	F. b. 2½x1 mm. to nasal side of eye.	Magnet applied; no impulse. F. b. not recovered; vision 4/200. M. and S.
21	6-23-19 (9,554)	Steel in R. eye; wound at upper temp. limbus; lens cloudy.	F. b. 7x1x¼ mm. in R. vitreous.	Magnet removed by ant. route; hemorrhage; no vision; enucleation advised. M. and S.
22	7-4-19 (9,647)	Dyn. cap explosion; lens opacities; fundus normal.	Two small particles in right vitreous.	F. b. not removed. Vision 20/50. J. J. M.
23	8-15-19 (9,908)	Flying steel in R. eye; wound through cornea; lens cloudy.	F. b. 3x2x2 mm. just behind lens in vitreous.	Magnet removal; infection followed and eye was enucleated. M. and S.
24	9-3-19 (9,999)	Hammering board; f. b. in L. eye; small wound at temp. limbus; lens cl.	F. b. 3x2x1 mm. in vitreous, far back.	Extracted by magnet, ant. route; later became irritable and was enucleated. M. and S.
25	9-22-19 (10,148)	Scleral wound; lens and cornea clear.	4x4x3 mm. f. b. in vitreous.	Magnet extract. through wound of entrance; much intra-ocular injury; L. P. only. M. and S.
26	9-25-19 (10,197)	Explosion.	F. bs. about each eye; 2 localize inside R. globe.	Enucleation of R. eye. E. C. B.
27	9-27-19 (10,200)	Blast; extensive injury to both eyes.	F. bs. in each eye.	Eyes destroyed; no sight. M. and S.
28	10-13-19 (10,337)	Cap explosion; incised wound across cornea; lens extruded.	F. b. 2x1 mm., probably copper, in vitreous.	Enucleated; copper found as localized, in pus focus in vitreous. M. and S.
29	10-17-19 (10,375)	Shot in face; no visible wound of globe; blood in vitreous.	Shot size f. b. behind globe near optic nerve.	Shot not molested; no L. P. Probably injury to nerve. M. and S.
30	11-14-19 (10,638)	Cap explosion; large wound in temp. side of cornea; f. bs. seen in ant. chamber.	No definite shadow of f. b. shown by X-ray.	Infection; enucleation; f. b. found in ant. chamber as noted; not shown by X-ray. M. and S.

TABULATION OF FOREIGN BODY LOCALIZATIONS IN THE EYE—*Continued*

Ser. No.	Date and X-ray No.	History and Injury	Localization	Treatment and Result
31	11-28-19 (10,742)	Rock fell in eye; f. b. buried in cornea.	Shown on dental film beside eye.	Non-magnetic; not removed. Iridectomy for old iritis. M. and S.
32	12-23-19 (11,011)	L. eye struck; wound in sclera 7 mm. from temp. limbus.	F. b. 4x3x3 mm. in vitreous	Magnet removal through wound of entrance; mo. later no vision, detached retina; enucleation rec.
33	1-5-20 (11,123)	Hammering; struck in R. eye; no wound of globe.	F. b. below and in front of globe.	Could be felt in margin of orbit; not molested. M. and S.
34	1-6-20 (11,138)	Wound in R. eye region by bird shot.	Shot localized in orbit, near but not in the globe.	Not removed, as vision was not affected. V. M.
35	1-9-20 (11,167)	Hammering on metal (1918); struck in eye; scotoma and vit. opacities.	Small f. b. not def. localized in globe.	No treatment recorded; not seen afterwards. M. and S.
36	1-19-20 (11,672)	Blasted 1-1-20; ext. inj. to L. eye.	No f. b. localized in globe; one to temp. side.	Vision 15/200; R. eye 15/15. No surgical treatment, unless eye becomes irritable. M. and S.
37	2-20-20 (11,676)	Picking in rock; L. eye struck; claims no prior injury; no wound.	Small f. b. (rock?) in lower part of vitreous.	Old intra-ocular changes; injury positively not of recent occurrence. M. and S.
38	3-22-20 (12,058)	6 yrs. L. eye injury; 2 yrs. before, when hammering in steel.	F. b. in scleral wall of temp. side; 5x3 mm.	Removed with giant magnet; no visual disturbance. M. and S.
39	4-8-20 (12,306) (12,350)	2 mos. ago had f. b. in R. eye while grinding on emery wheel.	F. b. in ant. chamber; movable; two locations.	Removed by magnet, ant. route; lens was cloudy and was later extracted. M. and S.
40	4-20-20 (12,481)	F. b. in R. eye 14 yrs. before; spots in front of eyes now.	Very small f. b. shown in globe; not definitely localized.	Spots not due to f. b. Vision normal. F. b. doing no harm and not molested. M. and S.
41	5-29-20 (12,932)	Steel in R. eye 2 wks.; scleral wound on nasal side.	F. b. post. to globe in midline of orbit.	Not molested; vision lost account vitreous hemorrhage; F. b. went through globe. M. and S.
42	6-1-20 (12,962)	Dyn. cap; extensive injury to each eye.	F. b. found in each globe.	F. bs. not removed; left eye total loss; L. P. in right. M. and S.
43	6-9-20 (13,068)	Blasted in face; ext. injury to each eye.	One f. b. located in R. eye; none in left.	Corneal f. bs. removed and traumatic cataracts operated on; L. P. only account corneal opac. M. and S.
44 M. and S.	7-31-20 (13,625)	F. b. injury to each eye; cap explosion (?); R. eye injured more.	2 f. b. in R. vit.; 1 f. b. against L. sclera.	R. eye enucleated 8-5-20. F. b. in L. sclera not molested. No eye disturbance up to 8/10.
45 M. and S.	10-7-20 (14,219)	Explosion; piece of rock seen in lens; more f. bs. in each cornea.	Particles not shown by X-ray.	L. P. only in R. eye; corneal particles removed; enucleation of R. eye advised.

TABULATION OF FOREIGN BODY LOCALIZATIONS IN THE EYE—*Continued*

Ser. No.	Date and X-ray No.	History and Injury	Localization	Treatment and Result
46 M. and S.	10-9-20 (14,249)	Dyn. explosion 6/10; linear scar across cornea of L. eye; much intra-ocular damage.	Many f. bs. about eye; none localized in globe.	R. eye had been removed; L. eye had L. P. only and was irritable; probably small f. b. particles in globe.
47 M. and S.	10-22-20 (14,429)	R. eye struck by steel which was buried deep in cornea.	Localization indicated ant. chbr. (error of 1 mm.).	Removed by giant magnet. No visual disturbance. Error due to edema of conjunctiva.
48 M. and S.	12-11-20 (14,982)	4 wks. before, hammering on steel; L. eye injured; corneal scar.	Small dense f. b. behind center of cornea in vit.	Magnet extraction through inf. temp. opening in sclera; steel 2 mm. diam. Eye quiet; L. P. on 12-5-21, with cataract.
49 M. and S.	12-21-20 (15,062)	2 mos. old injury to L. eye; scar ext. limbus; lens opaque.	Small f. b. lying against post. border of lens.	Magnet extraction, ant. route; cataract left; eye quiet.
50 M. and S.	12-22-20 (15,058) 12-11-23 (24,077)	Inj. 4 yrs. before; rock (?) in R. eye; lens opaque; L. P. only; 2 exams., both same.	Each localization shows double shadow in vit.; has density of rock.	No treatment first exam. At second, magnet applied but no impulse; not disturbed further.
51 M. and S.	1-11-21 (15,278)	Blasted 12/23; many corneal f. bs.; both lenses clear.	Locates f. b. in each vitreous, besides corneal.	Many superficial corneal bodies removed; deep corneal bodies left 1/28, vision R. 15/20; L. 5/50; localization considered error.
52 M. and S.	1-14-21 (15,320)	Struck in R. eye by stick; corneal wound; lens opaque; vision nil.	Dense f. b. below and to nasal side of eye.	Has been mechanic; does not recall any accident to explain steel f. b. Not removed.
53 M. and S.	1-22-21 (15,478)	Rock in L. eye in 1919; eye quiet; lens cloudy. Sept., 1920, struck in R. eye with rock.	F. b., of low density, 1 mm. diam. in vitreous R. eye.	R. eye being best eye, nothing was done. 8-30-22, R. eye becoming irritable and L. cataract was extracted.
54 M. and S.	5-2-21 (16,616)	R. eye struck by particle from cold chisel; large wound cornea.	F. b. 5x2x3 mm. in orbit posterior to globe.	Removed through canthotomy opening by magnet, without disturbing eye. Eye preserved with L. P.
55 M. and S.	6-15-21 (17,012)	Blasted; many f. bs. in each cornea.	F. bs. in contact with globe.	Corneal f. bs. removed; vision good on R.; 2/200 on L.
56 F. L. R.	8-10-21 (17,393)	Working on car; wound over R. pupil; lens injury.	F. b. localized in vitreous.	Advised extraction with magnet; refused; patient not seen since. D. F. H.
57 M. and S.	8-16-21 (17,416)	Steel in L. eye 1908; one mo. particle in cornea removed.	F. b. 2x1 mm. in ciliary area lower edge.	Claims disability from recent slight injury; eye changes all old; not removed.
58 M. and S.	10-17-21 (17,855)	Blasted; many corneal f. bs. Perforation in center of L. cornea.	One f. b. in ant. chamber L. eye; none in R. globe.	Superficial f. bs. removed. F. b. not removed from L. eye; vision, O. D., 15/20; O. S., 15/50.
59 M. and S.	10-25-21 (18,213)	F. b. in R. eye in 1917 shown post. to globe; eye now quiet.	F. b. 3x1 mm. is just behind globe, temp. side.	Doing no damage; vision 7/200; not molested.
60 M. and S.	11-26-21 (18,219)	Blasted 4-13-21; bad injury to each eye with cataract.	Multiple f. bs.; one in left vitreous; R. side doubtful.	Treated elsewhere until sent for operation, for new pupil in R. eye. Rock in each eye.

TABULATION OF FOREIGN BODY LOCALIZATIONS IN THE EYE—*Continued*

Ser. No.	Date and X-ray No.	History and Injury	Localization	Treatment and Result
61 M. and S.	3-17-22 (19,128)	Blasted Oct., 1921; many f. bs. removed from cornea.	Inaccurate on account inability to fix vision.	Corneal f. bs. removed; one f. b. from R. iris; cataract removed from L. eye.
62 J. J. M.	6-16-22 (19,817)	Dyn. cap explosion; perforated iris and traumatic cataract.	F. b. not localized in globe.	Needled cataract 7/15; 3 mos. later reported by mail vision normal.
63 M. and S.	6-30-22 (19,913)	3 yrs. before gun shell exploded near him; R. eye now blind (8 yrs.).	Very small f. b. localizes in vit. of R. eye.	Eye quiet; vision, hand movements only. No treatment.
64 M. and S.	7-8-22 (19,945)	After dancing had pain in eye; no visible injury to eye.	2 f. bs., one localizing in R. vit., far back.	No record of treatment.
65 M. and S.	7-25-22 (20,032)	Explosion; multiple injuries to eyes.	No f. b. in globe; several in area.	Corneal f. bs. removed; vision fair in each eye.
66 M. and S.	8-22-22 (20,182)	F. b. in R. eye in auto race; 1 mo. before; corneal scar; L. P. only.	Very small dense f. b. in vitreous of R. eye.	Eye quiet; cataract; vision, fingers at one foot; treatment refused.
67 D. F. H.	9-11-22 (20,299)	Drilling; f. b. struck R. eye; lens disl. into ant. chamber.	1x1½ f. b. in vit., lower segment, to nasal side.	Magnet tried; not successful; eye enucleated and f. b. found as indicated.
68 M. and S.	10-5-22 (20,472)	Drilling; f. b. in L. eye; entrance through lower edge of pupil.	Dense f. b. 5x1 mm. in vitreous of L. eye.	F. b. removed through scleral opening with magnet; 11-13-23, eye quiet; cataract; L. P.
69 G. M. B.	11-4-22 (20,759)	Shotgun accident; wounds about eye.	No shot localized in globe; one in floor of orbit.	Not molested.
70 M. and S.	11-17-22 (20,833)	Drilling; thought was struck by rock R. eye; small corneal wound and lens opacity.	F. b. 1 mm. diam. against sclera in vitreous of R. eye; metallic density.	Could be seen with scope; drawn through zonula with magnet and extracted ant. route; cataract reduces vision.
71 H. L. G.	11-24-22 (20,906)	Injury some time in past.	Shadow in R. orbit which does not localize in globe.	Medico-legal question of localization of this shadow, reported as being in eye.
72 M. and S.	1-25-23 (21,576)	Blasted 1/10; many f. bs. in cornea of each.	Probably 1 f. b. in R. sclera; others near by.	Many f. bs. left in cornea of each eye; R. eye irritable; may have f. b. in globe.
73 M. and S.	2-16-23 (21,613)	Putting in stull; f. b. in L. eye; large corneal wound nasal seg.	F. b. 5x3 mm. in ciliary region temp. side L. eye.	Removed through wound of entrance by magnet; infection resulted; enucleation 2-20-23.
74 M. and S.	2-20-23 (21,653)	Blasted; both corneæ filled with rock.	At least 1 f. b. (rock?) in each globe; many near.	R. eye destroyed; after enlarging and clearing pupil on L., vis. 6/100 on 12-5-24.
75 M. and S.	2-23-23 (21,686)	Hammer on steel; L. eye injury; small wound nasal side of cornea.	Long narrow f. b. post. to globe on temp. side.	Not molested; by April 6, inflammatory reaction had subsided and eye was quiet; cataract; L. P.
76 M. and S.	4-18-23 (22,208)	Steel L. eye in 1897; not removed; R. eye now irritable.	F. b. 3x1 mm.; dense; well back in L. vitreous.	No vision L. eye, but irritable; enucleation advised to prevent sympathetic trouble on R.
77 H. Y.	5-11-23 (22,455)	Using hammer on metal, piece struck L. eye; deeply embedded.	F. b. localized in scleral wall nasal side L. eye.	Magnet extraction; 20/20 vision.

TABULATION OF FOREIGN BODY LOCALIZATIONS IN THE EYE—*Continued*

Ser. No.	Date and X-ray No.	History and Injury	Localization	Treatment and Result
78 M. and S.	5-28-23 (22,600)	Blasted; numerous f. bs. in corneæ and about eyes.	No f. b. localized in either globe; many near by.	Many corneal bodies removed; some left in; L. eye still inflamed 7/24; vision on L. P. on left; on R. 15/15.
79 M. and S.	6-25-23 (22,837)	Chiseling; wound corneal margin L. eye; lens opaque.	2 dense f. bs. lying close together in vitreous.	Extracted by magnet post. route; came out together; subsequent observation not recorded.
80 M. and S.	7-10-23 (22,896)	Drilling; L. eye injury; wound inf. portion cornea.	Dense f. b. 2x3 mm. in vit. above and to nasal side.	Scleral opening 6 mm. post. to limbus; magnet extraction; L. P. only account of cataract.
81 M. and S.	7-12-23 (22,922)	Blast in face; many corneal f. bs.; cataract each eye.	Many f. bs. about eyes; one in each globe.	Many bodies removed from each cornea; R. eye later enucleated; L. eye cataract removed; L. P.
82 M. and S.	7-13-23 (22,925)	Inj. 16 yrs. before; dyn. cap; R. eye lost; some vision in L. eye.	F. b. 1x2 mm.; not very dense, in L. vit.	Probably copper; not removed; shows tolerance of eye for copper.
83 M. and S.	8-1-23 (23,012)	Broke nose; claims eye injury; signs of old R. eye injury.	F. b. ½x½ mm. in region ciliary body R. eye.	Old eye injury with optic atrophy; no connection with present injury; eye blind.
84 M. and S.	9-5-23 (23,222)	7-1-23 struck in R. eye; no X-ray; has scar in cornea and lens.	Small dense f. b. within lens, R. eye.	Removed giant magnet, ant. route; discission lens 10//126; has had left cataract removed.
85 M. and S.	9-15-23 (23,292)	Dyn. cap; both eyes injured; R. eye worse; traumatic lens.	Small f. b. in each vitreous; some doubt in location.	R. eye totally blind; new pupil made in L. eye; see fingers at 1 foot.
86 M. and S.	10-1-23 (23,409)	Blast in face; iris and lens injury, each eye.	Many rocks about eyes; one in R. globe; L. eye (?).	R. eye total loss; operations on L. with L. P.; not certain about f. b. in left eye.
87 M. and S.	10-30-23 (23,690)	Hammering on pipe; hit L. eye; scleral wound on temp. side.	F. b. in sclera on temp. side of cornea; rock (?).	Was piece of steel; removed by magnet; very thin scale; error in interpreting density.
88 M. and S.	11-12-23 (23,810)	9-6, tapping punch, hit R. eye; no visible scar on 11-12; no pain now.	Dense f. b. 1x2 mm. well back in vit. of R. eye.	Is not disturbing eye or vision at present; would not permit removal.
89 M. and S.	11-12-23 (23,811)	Blasted; many wounds about face and eyes.	Many f. bs. about eye; none inside globe.	Corneal scars; no intra-ocular injury; vision 20/20 each eye.
90 M. and S.	11-14-23 (23,818)	On 10-22 cut on cornea; no f. b. suspected; lens opaque.	Small dense f. b. in vitreous of L. eye.	Removed by magnet ant. route; May, 1924, cataract removed; vision 15/30 with correction.
91 M. and S.	11-21-23 (23,903)	Blasted; f. bs. in R. eye (superficial); perforating wound.	Did not localize f. b. shadows in either eye; some near by.	Treated until Jan. 12, and discharged with good vision each eye.
92 M. and S.	11-26-23 (23,948)	Blasted; perforating wounds each globe; many corneal f. bs.	Numerous f. bs. and 1 in left eye; none located in R. globe.	R. eye destroyed; L. P. only in left; many rocks in each orbit and perhaps in each globe.
93 M. and W.	11-28-23 (23,958)	Blasted; many f. bs. about eyes and in cornea of each side.	At least 1 f. b. localized in each globe (rock).	L. P. in each eye; right may have to be enucleated; has rock in each globe.

TABULATION OF FOREIGN BODY LOCALIZATIONS IN THE EYE—*Continued*

Ser. No.	Date and X-ray No.	History and Injury	Localization	Treatment and Result
94 M. and S.	12-14-23 (24,129)	Blasted 11-27; severe injury to each eye, but worse on R.	No f. b. shown inside globes; many just against them.	R. eye destroyed; corneal f. bs. removed from left; few small ones left; vision 15/20.
95 D. F. H.	1-1-24 (24,289)	Dyn. cap explosion; many f. bs. about both eyes.	Many f. bs. about eyes; one in L. vit.; none in R. globe.	Magnet tried; no result. Eye said to have been removed by another doctor.
96 M. and S.	1-30-24 (24,616)	Working cement floor: 2 mm. linear wound at L. nasal limbus.	F. b. 1x½ mm. in vit. of L. eye, far back.	Magnet applied; relocalization showed f. b. in ciliary region; removed ant. route; lens opacity.
97 J. J. M.	2-1-24 (24,643)	Hammering on steel; f. b. struck L. eye.	Small dense f. b. in nerve head of L. eye.	Small magnet unsuccessful; giant magnet removal; iridocyclitis; enucleation.
98 M. and S.	2-21-24 (24,866)	Injury to R. eye; all intra-ocular structures normal.	F. b. just outside of globe, nasal side.	F. b. removed; no damage to intra-ocular structures or vision.
99 M. and S.	3-4-24 (25,000)	Flying steel L. eye; corneal wound 3 mm. from inf. nasal limbus.	Dense f. b. 1x2 mm. on floor of vit. L. eye.	Drawn out by magnet through wound of entrance; cataract removed; eye O. K. June 2.
100 D. F. H.	4-28-24 (25,603)	Flying steel in L. eye; no notes on appearance.	1x2 mm. f. b. in post. scleral wall.	Not extracted; on June 11 eye was quiet and vision 15/40.
101 M. and S.	4-28-24 (25,615)	Blasted; both eyes injured; corneal wound on R.	F. b. in vit. on R.; one against cornea on left.	R. eye enucleated in June; rock in vitreous; left eye quiet with some lens opacity.
102 M. and S.	6-13-24 (26,111)	Explosion; many f. b. wounds of each eye.	Many f. b. shadows about eyes; not def. localized.	R. eye enucleated on account trauma; vision left 10/200.
103 M. and S.	6-28-24 (26,240)	Chipping on brass; perforating wound of sclera, nasal side.	Very large f. b. in vit. of R. eye, 9x4x2 mm.	Piece of brass removed by forceps through scleral opening. Sept. 9, eye quiet; some vision.
104 M. and S.	7-29-24 (26,455)	Rock (?) in R. eye; small linear scar in cornea; lens cloudy.	Small fleck ½ mm. diam. in lens.	Removed by magnet ant. route. Sept. 10, vision 15/40 with small corneal opacity; lens clear.
105 M. and S.	8-27-24 (26,637)	Flying metal R. eye; corneal wound, nasal side.	Large dense f. b. in upper part of orbit, outside eye.	Evidently wounded cornea in passing; not removed; some corneal scar left.
106 M. and S.	9-8-24 (26,709)	R. eye struck while watching; 4 mm. wound of cornea, nasal side.	Shadow external to globe; not metal.	Eye cleared with slight cloudiness of lens; no f. b. though intra-ocular changes.
107 M. and S.	10-4-24 (26,997)	Chiseling; L. eye inf.; linear wound, cornea; lens cloudy.	Dense f. b., 1x2 mm. in vitreous, L. eye.	Removed by giant magnet: traumatic cataract removed 10-26, but no vision.
108 M. and S.	10-27-24 (27,261)	Breaking rock; L. eye inj.; wound of cornea; iris prolapsed.	No. f. b. shadow found in globe; one near by.	Iris amputated; recovery of eye and vision (15/15); R. eye blind, previous injury.
109 M. and S.	10-31-24 (27,324)	Rock (?) struck L. eye; no visible wound of globe.	Dense f. b. 2x1½ mm. in ciliary region L. eye.	Magnet extraction ant. route; 2-10-25, vision 15/50.
110 M. and S.	11-21-24 (27,592)	Both eyes injured some weeks before.	Many f. bs. near eyes; one against R. sclera.	R. eye enucleated account infection; corneal opacity on left; vision, fingers one foot.

TABULATION OF FOREIGN BODY LOCALIZATIONS IN THE EYE—*Continued*

Ser. No.	Date and X-ray No.	History and Injury	Localization	Treatment and Result
111 M. and S.	11-26-24 (27,655)	Cap explosion; R. eye wound at nasal limbus.	Did not show f. b. localizing in eye.	Blood clot in vit. Eye was later enucleated; no record as to whether f. b. was found.
112 M. and S.	12-4-24 (27,736)	Blasted 10-12; several corneal scars.	F. bs. near but not within globe.	Vision somewhat interfered with by corneal scars.
113 M. and S.	12-6-24 (27,771)	Blast; wound of cornea and lens on left.	Small f. b. rock (?) in vitreous.	Infection and enucleation; rock found in vitreous.
114 M. and S.	12-24-24 (27,961)	Cap explosion; both eyes injured.	Small f. b. in L. behind lens; no f. b. located in R.	F. b. seen by scope in R. lens; L. lens opaque; neither eye molested; copper f. b. in each.
115 M. and S.	12-27-24 (27,993)	Exploded percussion cap; no corneal wound; intra-ocular damage.	Dense f. b. below and to nasal side of R. eye.	F. b. not molested, as probably globe was not penetrated.
116 F. L. R.	1-29-25 (28,433)	Auto mechanic; chipping; f. b. in R. eye.	Against sclera above hor. plane.	Magnet; three subsequent localizations showed no change in position; embedded or non-magnetic.
117 M. and R.	2-13-25 (28,607)	Blasted 12-13-24; many f. b. injuries to each cornea.	Many f. bs. near each eye, but not within.	Superficial corneal bodies removed; deep ones left. Vision L. 15/50 and R. 15/30.
118 P. and G.	2-17-25 (28,811)	Explosion.	Several f. bs.; one against ext. scleral wall R. eye.	Record of treatment and result not available.
119 M. and S.	3-5-25 (28,908)	10 yrs. before, f. b. in L. eye; vision failing; lens opaque.	Thin f. b. 2½x1 mm. in vitreous; density of metal.	No vision; irritable; enucleated and f. b. found.
120 M. and S.	3-19-25 (29,122)	Explosion; many f. bs. in each cornea.	Many f. bs. near globe, but none within either.	Superficial bodies removed; deep ones left; vision 15/40 each side, with correction.
121 M. and S.	3-20-25 (29,154)	R. eye injury; two recent corneal scars.	F. bs. about each eye; one in R. post. chbr.	F. b. changes position; localized in post. chamber; later in ant. chamber on opp. side of pupil.
122 M. and S.	4-3-25 (29,343)	Blasted; many corneal injuries of each eye.	F. b. not definitely localized in either globe.	L. eye enucleated; copper f. b. in vitreous. Lens extracted on rt.; may have f. b. in vit.
123 M. and S.	4-15-25 (29,565)	Blasted; numerous f. b. injuries each eye.	Many faint f. b. shadows; none def. within globe.	Both eyes destroyed; bodies in each globe; too small and faint to show by X-ray.
124 M. and S.	4-15-25 (29,566)	Cap explosion; wound through center of cornea.	Rock (?) 1 mm. diam. in vitreous of R. eye.	Eye enucleated and f. b. found in position shown; does not state whether copper or rock.
125 M. and S.	5-8-25 (29,994)	Explosion; R. corneal scar; no intra-ocular changes.	Very small particles adjacent to globe; none in.	Eyes quiet on May 14; vision not disturbed in either eye.
126 M. and S.	5-18-25 (30,181)	7 mos. before struck in eye when picking; 5 da. drop of oil fell in eye.	Small dense f. b. 1x½ mm. in vitreous L. eye.	No recent injury; L. P. only in eye; f. b. removed by magnet; suppurated; enucleation advised.
127 M. and S.	6-12-25 (30,514)	Blasted; many f. bs. on cornea each side.	Small f. b. in L. globe; none found in R.	Both eyes irritable; cataract removed from L. eye (V. 15.40); believe fine f. b. in R. eye.

TABULATION OF FOREIGN BODY LOCALIZATIONS IN THE EYE—*Continued*

Ser. No.	Date and X-ray No.	History and Injury	Localization	Treatment and Result
128 M. and S.	6-27-25 (30,732)	Age 12; hammering; R. eye perforating wound of cornea nasal side.	2½x1 mm. f. b. in lower ciliary area R. eye.	Magnet extraction ant. route; tension minus; prognosis not good.
129 M. and S.	7-4-25 (30,795)	L. eye inj. in 1904; no vision; R. eye now irritable.	2x1 mm. f. b. in L. vit. against scleral wall.	No treatment at present; glasses.
130 M. and S.	8-8-25 (31,124)	Age 12; dyn. cap exp.; wound lower limbus; lens opaque.	1x1 mm. f. b. in vit. R. eye; dense like metal.	No magnet response; advised enucleation as no vision, and may become irritable.
131 M. and S.	8-15-25 (31,196)	Blasted; many f. bs. in each cornea.	Many f. b. shadows near globe; none inside.	Corneal f. bs. removed; intraocular injury to left eye; cataract; eye quiet Nov. 30.
132 M. and S.	10-23-25 (32,044)	Struck steel 9-27; removed; not certain that all removed.	Very small f. b. in lens area.	Removed by giant magnet; vision 20/20.
133 M. and S.	11-19-25 (32,489)	Injured 11-15; blast in face; both eyes; many f. bs.	Did not localize f. b. in either globe.	L. eye enucleated; R. eye saved with 15/20 vision after correction.
134 M. and S.	12-18-25 (35,951)	Picking rock; R. eye corneal wound; lens opaque.	2x3 mm. f. b. in R. vitreous; density of metal.	Magnet extraction through wound of entrance; infection; enucleation.
135 M. and S.	12-28-25 (33,072)	Blasting cap; wound center of cornea.	Small f. b. in vit. L. eye, of metal density.	Eye continued inflamed and was enucleated Jan. 26; copper f. b. found as located.
136 M. and S.	2-5-26 (33,700)	Powder explosion; many f. bs. each cornea, 175 in R. and 375 in L.	All visible f. bs. external to the globes.	Eyes quiet on May 10; fair vision each eye; slight opacity left lens.
137 S. S.	2-5-26 (33,715)	Does not know how injury was sustained; poor vision.	1x½x½ mm. f. b. in ant. chamber R. eye.	Patient did not return for treatment.
138 M. and S.	2-10-26 (33,779)	R. eye injury; perforating corneal wound.	Dense f. b. in post. scleral wall.	Infection; enucleation; f. b. found as located.
139 M. and S.	2-10-26 (33,783)	Explosion; corneal injuries each eye.	F. bs. all outside of globe, near by.	Not molested; eyes recovered, with normal vision.
140 M. and S.	3-10-26 (34,192)	Blast in face; many f. b. injuries each eye.	F. b. in L. globe; very faint shadows.	Both eyes destroyed by force of blast and corneal f. bs.
141 D. F. H.	3-8-26 (34,209)	Dyn. cap explosion; many f. bs. about eyes.	Not. def. localized in eye.	Eye later removed on account of panophthalmia; no f. b. found in globe.
142 M. and S.	4-8-26 (34,731)	Percussion cap; copper particles about L. eye.	Pinpoint densities over globe area.	Very small f. b. seen in lens. Proved to be magnetic and was removed with magnet; some lens opacity. Older injury?
143 M. and S.	5-26-26 (35,644)	Wound through upper lid; no intra-ocular signs; no vision or L. P.	Large f. b. post. to globe in nerve area.	Swelling and edema subsided; f. b. not removed; probably injured nerve.
144 M. and S.	6-2-26 (36,233)	Cleaning pipe 6 wks. before; struck in R. eye; corneal scar.	Small dense f. b. far back in vitreous of R. eye.	Could see a pinpoint size f. b. in lens also, not shown by X-ray; both f. bs. removed by magnet; prognosis good.

Addenda

Ser. No.	Date and X-ray No.	History and Injury	Localization	Treatment and Result
145 M. and S.	6-16-21 (17,012)	Blasted; many f. bs. in conj. and cornea.	No f. bs. localize within the globe on either side.	Corneal f. bs. removed; lens opacity on L., vision 2/200; lens clear on R., vision 15/15.
146 M. and S.	6-16-21 (17,015)	Blasted, with many corneal f. bs. on each side.	On R. one f. b. on sclera, temp. side; none in L. globe.	Corneal particles removed. R. vision, hand movements; L. 15/100. Corneal opacities.

DISCUSSION

DR. M. J. HUBENY (Chicago): I am very glad to have heard this paper by Dr. Mills and Dr. Watkins, and those of you who have not seen the exhibit ought to go down and study the charts, because I think the examination has a certain usefulness in every community and some one should be prepared to do that kind of work, because of several reasons. First, it is not necessary to argue the value of the cosmetic sense or the value of retaining the functioning of an eye, and second, we in the X-ray profession have a certain legal responsibility. The industrial boards make certain awards because of the incompetency of the individual to keep on with a certain vocation, and therefore we are held, in a certain measure of legal responsibility, as to whether or not we mis-localize the foreign body. I really cannot add anything to this paper, only that in making out reports there are several little loopholes one wants to allow himself, and the report I have been in the habit of making gives me two loopholes, which are desirable if one is caught in a jam. It is not grammatically correct, nevertheless it is a redundancy which is permissible: "The X-ray examination of Mr. So-and-So's left eye appears negative for foreign bodies opaque to the X-ray." You see the word "appears" gives you a loophole; you can argue, in a court of law, that you did not say that there was no foreign body present. The other thing is that the examination contemplates a foreign body opaque to the X-ray. It is not good grammar, but it is permissible because it fortifies the preliminary remarks that you have confined yourself to the X-ray examination. There are several things a man really ought to do to eliminate the unnecessary expenditure of money. When a patient comes in for an examination, we take two films, one directly on top of the other, and have the patient lie on the side; for instance, have the right side of the patient down and half of the film covered with a sheet of lead. As it is necessary to have the eye absolutely stationary, we have the patient look at an object a few feet away, and tell him what we are going to do, and ask him to exercise due caution to keep his eye perfectly quiet. Then we take an exposure, raise the head, shield the part that has been exposed with this piece of lead, put the face down on the unexposed half and take another exposure. The purpose of taking two films is the desirability of eliminating errors due to defects in the plate. Occasionally one has a small flaw in the plate for some unknown reason, possibly the intervention of an opaque medium of some kind, a little piece of lead or metal, that, instead of being in the eye may be in or near the film. So one purpose of taking two films is merely the exclusion of the possibility of an artefact, and the other is that if there is no foreign body apparent we eliminate the tedious operation of a localization. Industrial companies appreciate that, because they do not want to have exorbitant fees, and for this minor examination one can easily get ten dollars and that is all it is worth; for the

localization one may charge from twenty-five dollars up, so I think we ought to take that into consideration.

Then there is another little incident with reference to bodies that are located in or near the periphery of the ocular outline. If you have noticed these charts, you have seen that you have a horizontal view, a lateral view, and an anterior view represented by a certain circle with a segment representing the cornea. If the foreign body lies in or near this circular outline—let us say it lies just within the circular outline—you would be inclined to say that it is in the eyeball. We almost had an unfortunate experience though it was not my fault: in a given instance, the foreign body was just within the periphery, and I made the diagnosis (because everything else checked up with it) that the foreign body was just within the eyeball. As a matter of fact, this body was just outside of the eyeball. If you have a foreign body located just within the periphery in all three elevations, you want to "watch your step," because, as this foreign body recedes from the equatorial plane in all three projections, the segment becomes smaller. That is where we made our mistake. I want to thank Dr. Mills for giving me this opportunity.

Dr. T. G. Clement (Duluth, Minn.): The ophthalmologists of Duluth like very much to remove foreign bodies as soon as possible after the injury. I therefore want to suggest a method of rapid localization of all foreign bodies in the eye—that is the fluoroscopic method. We do it this way: The patient is brought into the fluoroscopic room and we fluoroscope the orb itself. One cannot do it with a large diaphragm—it must be cut to the size of a postage stamp or very little larger. I have the patient move his head so that the fluoroscope rests over the eye as closely as possible, and put my hand on the other eyeball, and ask him to turn his eye to the right or left, so I can see where the foreign body is and in which direction it moves. If it moves downward when he looks up, or moves to the right when he looks to the left, it is in the back part of the eyeball. Then if it moves in the same direction he looks, it is in the anterior portion. To protect ourselves, if we can localize the foreign body in that way, we take the patient into the radiographic room and localize it by the Sweet method. Then he is taken upstairs and the attempt is made to remove the foreign body by a magnet. After that he is brought down and we again try to localize it by the Sweet method; that gives us a film with the foreign body in the eye and a film not showing any foreign body, but proving that it has been removed.

We often use dental films. I think the dental film is of finer grain than the ordinary film, and we have been able to demonstrate much smaller foreign bodies on it than on the ordinary film. We put it right in front of the eye. It has the advantage that there are two films in the pack, which eliminates the possibility of there being a defect in the film itself, which might be mistaken for a foreign body, as Dr. Hubeny has mentioned.

Dr. Mills (closing): Just a word or two in reference to the importance of records. The absence of a permanent record would be a very serious objection to the use of the fluoroscope in determining whether or not there was a foreign body in the eye. For our records, we make three copies of the localization chart, one for our files, to be filed along with the films, a second for the ophthalmologist, and a third for the physician referring the case to the ophthalmologist. In our organization, many of these patients come from distant parts of the State—from mine corporations, etc.

It is our custom to take at least two preliminary films, one right after the other, in the same position and same relation to the

eye. We do not use screens for this work. I think that is important, for, by using plain films, we avoid the danger of artefacts. As mentioned by one of the members who discussed the paper, occasionally it is of advantage to use a dental film, to determine the presence of very small objects of slight density in the cornea. By placing the dental film at the inner or outer canthus and angling properly with the dental cone, a foreign body in the cornea will be picked up once in a while that otherwise would not be found.

Tumors of the hypophysis.—This paper deals with 15 cases of tumors of the hypophysis, some presenting the symptoms of acromegaly (6), others only disturbance of vision (7), and the last group, of the adiposogenital complex (2). The radiation used was 180 K.V., 0.5 Cu. plus 1.0 Al., 2.5 ma., two temporal and one frontal field, 1 E.D. per field, depth dose percentage 28 to 30 per cent. Intervals between the two series were six weeks. The results are considered satisfactory, chiefly in the acromegalic type.

E. A. POHLE, M.D.

The Roentgenotherapy of Tumors of the Hypophysis. J. I. Heinismann and L. J. Czerny. Strahlentherapie, 1926, XXIV, 331.

Skin growths simulating calculi in X-ray plate.—This brief paper is one of value to the roentgenologist, and the few moments devoted to its reading may well save him from waste of time and material and the embarrassment of making a wrong diagnosis. Two cases are reported in which papillomata of the skin of the back cast shadows which resembled those cast by renal calculi, a condition to which attention has already been called by Holmes, Ruggles, Pirie, and Cabot. Chemical analysis of the excised growths showed in one case slight traces of calcium, phosphorus, and magnesium, while in the second case not even traces were discoverable. The authors conclude that the position of the growths (nearest the film), the fact that they were pedicled (almost completely surrounded by air) were contributory factors in intensifying the shadows cast. They proved these two points experimentally.

M. INGLEHART.

Radiographic Simulation of Renal Calculi by Papillomata of the Skin. M. M. Melicow and H. H. Gile. Surg., Gynec. and Obst., February, 1927, p. 230.

Operation or irradiation of uterine carcinoma.—Based on his clinical studies and experience, Eymer recommends radiation therapy for all carcinoma of the cervix and surgery for the fundus carcinoma.

E. A. POHLE, M.D.

Should Uterine Carcinoma be Operated on or Irradiated? H. Eymer. Strahlentherapie, 1926, XXIV, 149.

EDITORIAL

UNILATERAL EXOPHTHALMOS

The condition of unilateral exophthalmos is fortunately of rather rare occurrence, especially in view of the fact that so many difficulties in diagnosis are thereby presented. Roentgenography in many cases is of inestimable aid in clarifying the situation; however, on the other hand, cases present themselves in which the ultimate diagnosis should have been made by roentgenography, but in which the most carefully taken films failed to reveal the source of the protrusion. Before discussing this somewhat mystifying type of case, it might be well to review most briefly the more common causes of unilateral exophthalmos.

As a general classification, the following may be offered:

(*a*) Exophthalmos due to systemic disease;
(*b*) Exophthalmos due to a decrease in the size of the orbital tissue by encroachment by adventitious tissue;
(*c*) Exophthalmos due to a deformity of the orbit;
(*d*) Exophthalmos due to extra-orbital toxic agents;
(*e*) Exophthalmos due to infection;
(*f*) Exophthalmos due to trauma.

It is realized that in some of these classes there is not a sharp line of distinction and that a very definite overlapping may be claimed. Again, cases have been reported that do not seem to fall into any of these classes; but such cases are isolated individuals and are so rare as not to justify an additional class.

The most common type of Class A is the exophthalmos due to exophthalmic goiter, and, although this usually produces a bilateral protrusion, still cases of unilateral exophthalmos have been reported. Here as in the other cases that fall under this class, roentgenography is of no diagnostic aid. Whatever may be the mechanism of the protrusion, the retro-bulbar tissue is not sufficiently dense to obstruct the passage of the rays. These same statements hold true for Classes D and E, which will be dismissed herewith.

Class B must be subdivided before the diagnostic value of the roentgen ray can be discussed. For practical purposes, such a subdivision might be as follows:

(*a*) Brain tumor with intra-orbital extension;
(*b*) Intra-orbital ectasias of the accessory nasal sinuses;
(*c*) Intra-orbital osteomata;
(*d*) Intra-orbital exostoses;
(*e*) Intra-orbital vascular aneurysms;
(*f*) Intra-orbital tumors.

Intra-orbital extensions of brain tumors are rather uncommon and invariably are of the soft-tissue type of tumor, such as glioma, neuro-endothelioma, sarcoma, and so forth. The neurological symptomatology produced is usually such that the diagnosis is established easily, even without the aid of roentgenography. In the majority of cases, the new tumor masses are so easily penetrable by the roentgen ray that but little shadow is produced.

It is a rather startling fact that intra-orbital ectasias of accessory nasal sinuses occur principally in younger individuals, usually before the age of thirty and mostly

under twenty years. But a brief reflection as to the character of the adult bone that forms the orbit will reveal the answer. The majority of such ectasias originate in the ethmoid or sphenoid sinuses, although the frontal and antrum may be the source. It would seem as though a low-grade muco-purulent infection developed in one of the closed spaces and exerted pressure over a long period of time. At the point of the ectasia the bony wall of the orbit must be thin and there results a bulging of the sac into the orbit. This sac is composed of a thickened mucosa in a pouch-like form, filled with muco-purulent secretion. In some cases, the bony wall of the orbit seems to have become thinned and bulges inwardly, at the same time proliferating somewhat. In either case, the total contents of the orbit is increased sufficiently to cause the eyeball to protrude, and the direction of protrusion is governed somewhat by the location of the ectasia. Usually, the protrusion is downward and outward, since the ectasia is usually of ethmoidal or sphenoidal origin. In such a case, it might be expected that roentgenography would be of inestimable diagnostic aid, but in less than half the cases are there any definite shadows on the film. If the ectasia has no bony covering, a shadow can not be produced, while if the orbital wall has bulged inward with the ectasia, the bone is so thin that it is perfectly transparent to the roentgen ray. Furthermore, the shadows are apt to be masked by the dense surrounding bones that the ray has to penetrate before reaching the plate.

But at times the ectasias lead to bone proliferation and the formation of a true osteoma of the orbital wall. In such cases, the roentgenographic diagnosis is, of course, simple, and the veriest tyro can localize the bone tumor. This is usually located on the inner or inner upper wall of the orbit and is apt to have a broad base markedly larger than the apex. It is rather important to delimit the size of the base and its anatomical relationships very accurately in order that the surgeon may be guided thereby in his operative procedure. For example, were the osteoma located well back in the orbit and pendant from the roof, the surgeon would hesitate about removing the base of the tumor for fear of opening the cranial cavity.

Blunt traumata to the orbit not infrequently result in the formation of exostoses that encroach sufficiently upon the orbital cavity to cause an unilateral exophthalmos. The history of the trauma and the slow development of the protrusion of the eyeball are of diagnostic import. Here roentgenography may play a very important rôle in outlining the new-formed bone and determining the rate of progress. The absence of malignancy from such exostoses is well known and operation is deferred as long as is compatible with the ophthalmic picture presented. These exostoses are favorable for roentgen examination, as the new-formed bone is extremely hard and ivory-like.

Unilateral exophthalmos is not infrequently caused by vascular aneurysm of the orbit. Such a condition is not so difficult to diagnose clinically, as the compressibility of the eye into the orbit and the bruit heard upon auscultation give an immediate clue to the condition. The dilated aneurysmal vessels offer but little obstruction to the roentgen ray and films are of but negative aid.

Tumors behind the eyeball may present a shadow, upon roentgen examination, but, as a rule, they do not; consequently, the only real knowledge that may be gained is as to whether or not the orbital bones have been eroded at all.

Class C forms an extremely limited group of cases and embraces the unusual forms such as oxycephaly with unilateral exophthalmos, leontiasis ossei of one side, and so forth. Each case is practically a rule unto itself and general discussion of such a group is beyond the range of possibility.

Unilateral exophthalmos not infrequently follows a trauma to the orbit that would seem to be of but little importance. At times, this may be due to the exostoses previously discussed, but in other cases, no bony deformity of the walls of the orbit can be detected. In many of those cases there has been a penetration of the orbit by a foreign body that has remained lodged there, such as a splinter of wood, a bit of twig, or a small piece of metal. Ofttimes, the presence of the foreign body is not even suspected by the patient or the ophthalmologist, for the wound of entry may be so minute as to escape all but the most searching examination. The exophthalmos seems to be due to the decrease in the area of the orbital cavity occasioned by the formation of new tissue around the foreign body. Exact localization of the stranger by roentgenography is, of course, of vital importance.

Thus it may be seen that only in a limited number of cases is unilateral exophthalmos produced by a condition which allows of diagnosis by roentgenography; but the clinical diagnosis of the causes of unilateral exophthalmos is not such a simple matter, and seldom can it be foretold in which cases roentgenography will or will not be of the utmost importance. Therefore, practically all cases of unilateral protrusion of the eyeball should be subjected to a most searching examination by the roentgen ray, even though nothing of diagnostic import results. A simple antero-posterior exposure of the head is not sufficient, on account of the interfering shadows of neighboring structures. The van der Hoeve technic whereby the optic foramen is depicted in the center of the orbital shadow is essential, and a control plate of the unaffected orbit must be taken also. A plate taken to show the ethmoidal and sphenoidal sinuses is necessary for the information that it may convey, while a lateral stereogram of the affected orbit may reveal details hidden in other postures. If a foreign body is shown, a localization must be made. Then and only then can the roentgenologist say that the unilateral exophthalmos is due to some cause which cannot be depicted by roentgenography. But if positive evidence develops from any of the various exposures, it may result in saving not only the eye but even the life of the patient.

HARRY S. GRADLE, M.D.

ALL ABOARD FOR WASHINGTON

Radiologists planning to attend the Washington meeting of the American Medical Association, going *via* or from Chicago, and who desire to travel together, may have one or more Pullman sleeping cars if they notify me immediately regarding the accommodations desired. *Michigan and Ohio men can join the party en route.*

The Chicago Medical Society has selected the Baltimore and Ohio R. R. as its official route and will have special trains leaving Chicago at 1 P. M., May 15th and 16th. The train leaving Chicago at 1 P. M., Sunday, May 15, will land us in Washington in time for Dr. Arthur C. Christie's clinics, and is the train planned to carry the Radiologists' Special Sleeper (Car No. 611), which will be one of the new fourteen-section all-steel cars.

The usual one and one-half fare for the round trip, on the certificate plan, prevails. Be sure to get a CERTIFICATE when buying the railroad ticket, and have it read *via* B. & O. from Chicago to Washington.

Write me immediately so that I can enter your reservation on diagram and insure accommodations. The railroad company will acknowledge your reservation.

I. S. TROSTLER, M.D.,
812 Marshall Field Annex,
Chicago.

BOOK REVIEWS

CLINICAL APPLICATION OF SUNLIGHT AND ARTIFICIAL RADIATION, INCLUDING THEIR PHYSIOLOGICAL AND EXPERIMENTAL ASPECTS, WITH SPECIAL REFERENCE TO TUBERCULOSIS. EDGAR MAYER, M.D. Williams & Wilkins, Baltimore, Md., 1926. Pages 468. Price $10.

This extensive work represents a most excellent and comprehensive presentation of a subject that has aroused no little interest in the medical profession. The text is arranged in sixteen chapters and supplemented by a bibliography of fifty-seven pages. An appendix of thirty pages is devoted to the influence of light on biochemical reactions.

The subject matter contains a wealth of scientific and clinical information, and, interspersed as it is with frequent references to the literature, becomes a most valuable source of reference.

A chapter devoted to the X-ray treatment of tuberculosis covers most of the work that has been done on that subject. The conservative attitude of the author towards such methods is reflected in his conclusions. "The value of X-ray therapy for pulmonary tuberculosis is as yet problematical and its application should be controlled with great care." As regards the treatment of other forms of tuberculosis: "The X-ray can only be offered as an adjuvant and not as a form of therapy used to supplant general constitutional treatment. It is to be remembered, however, that the X-rays constitute a dangerous instrument in the hands of the untrained, and had perhaps better be confined to use in sanatoria."

J. D. CAMP, M.D.

HANDBOOK OF MEDICAL ELECTRICITY AND RADIOLOGY. By JAMES R. RIDDELL, F.R.F.P.S. William Wood & Company, New York, 1926. Price $2.75.

In this small book of two hundred and thirty-nine pages (239) the author attempts to discuss not only the entire field of roentgen diagnosis and therapeutics, but he also includes such subjects as electro-therapeutics, electrical reactions of nerves and muscles, and treatment with various forms of light. The discussion of the individual subject is of necessity very little more than a precise description of the various terms and procedures, with some indication regarding their use. Nevertheless, the book contains a surprising number of facts, clearly and concisely stated. The text is well arranged, and free from error.

In the chapter on Regional Examinations, some of the technical procedures described are not generally used in American clinics, perhaps not wholly to our advantage.

The book is written for medical students, to acquaint them with the physical agents employed in the practice of medicine—to this extent it is of value. It is not comprehensive enough to be used as a text-book.

GEORGE W. HOLMES, M.D.

The American Radiological Association of Registered Technicians is holding its annual meeting in Chicago on April 25, 26, and 27, 1927. Headquarters will be at the Sherman Hotel, where a banquet will be held on Tuesday evening, April 26.

Various demonstrations will be held in Chicago and technical and medical papers will be read before the Association.

This meeting will be of interest to all registered technicians.

ABSTRACTS OF CURRENT LITERATURE

INDEX TO ABSTRACTS IN THIS ISSUE

Problem of dosage.—In this article the author discusses in detail a paper by Holthusen dealing with the present status of the problem of dosage in roentgenotherapy. He emphasizes the fact that almost complete agreement has been reached with his own teachings, which have been criticized ever since first published in 1905. Dessauer concludes that no matter how perfect a physical dose unit may be established, it will always be necessary to connect this unit with the biological effect, as, for instance, the erythema dose. In other words, we need a unit for "action and reaction."

E. A. POHLE, M.D.

Remarks Concerning the Problem of Dosage. Friedrich Dessauer. Strahlentherapie, 1926, XXIII, 579.

Jejunal ulcers.—The author refers to theories to explain the occurrence of jejunal ulcers following gastro-enterostomy. He does not believe that the occurrence is necessarily a combined result of trauma and infection. He is more inclined to ascribe their occurrence to the damage on the mucous membrane of the jejunum by the acid contents of the stomach, and he refers to the work of Joekes, who established the fact that the normal contents of the jejunum in a human is, if anything, slightly alkaline. The author believes that there is another possible contributory cause in the inability or refusal of the patient to continue proper dieting, with the eating of unsuitable food, perhaps imperfectly masticated, and he discusses the rôle of faulty mastication to the extent of two paragraphs.

He believes that the reason he missed a large percentage of jejunal ulcers, in the early period of his work, was faulty technic. With his present technic, a large majority of these ulcers can be accurately located. His method is the same as that used for gastric work, *i.e.*,

systematic radioscopic palpation, but with a small quantity of the meal instead of a full stomach. The main features are: (*a*) a meal of creamy consistency (he uses a mixture of his own, now sold under the name "Ramul"); (*b*) only three ounces of this is given at first, as six to seven ounces would defeat the object. By bimanual palpation, he smears the cream over each section of the mucous membrane systematically—he calls it "whitewashing" the interior of the stomach. The systematic examination of the whole stomach and duodenum must be emphasized, *i.e.*, the "whitewashing" process must start at the cardiac end, working down each side and ending at the jejunum. He states that full control over the meal by this method takes some time to acquire, and that much practice is necessary to acquire the knack.

When a case of suspected jejunal ulcer, after gastro-enterostomy, is being examined, there are certain modifications of this technic to be employed. One mouthful of the meal only is swallowed and as soon as it has reached the cardiac end of the stomach it is held by the palpating hand and controlled by this means; the emulsion is then slowly maneuvered through the stoma. The left hand is to prevent, by gentle pressure, any of the meal passing farther into the body of the stomach, for, if the pylorus is passed, shadows in the afferent limb of the jejunum will cause confusion. The right hand dams up with the emulsion in the first few inches of the efferent limb. This is not always easy. The cream is now manipulated backwards and forwards through the stoma into the jejunum and back into the stomach. This process will cause the opaque substance to adhere in any ulcer crater present, which shows as a black fleck or spot, which remains isolated after the displacement of the contents by pressure. This fleck, as in gastric ulcers, shows denser than the surrounding meal. The penetrating type of ulcer is more usual and easier to detect, as a nipple or bud-like projection on the jejunal wall, and this will also remain filled after the displacement of the contents. Pressure of the right hand is then released, allowing the contents to flow on into the remainder of the jejunum. Six inches from the stoma may be considered the limit of jejunal ulceration. Scott then gives the remainder of the meal and the rest of the stomach is examined as a matter of routine. Ulcers may occur around the anastomosis or several inches from it, usually just opposite the stoma itself. It is notable that they are seldom found in the afferent side. He has found the majority of them in the angle formed by the greater curvature of the stomach and the efferent limb of the jejunum. The closer the ulcer is to the anastomosis, the deeper it will lie in this angle. The true ulcer is usually of the penetrating type and is found, as a rule, projecting from the inner surface of the jejunum, well out of the gastro-jejunal angle. Deep pressure in this angle will help in many cases to demonstrate the ulcer.

He again emphasizes the difficulties of this method for the beginner and the fact that a full meal will overlap the diagnostic features of ulceration. He places little reliance on roentgenograms alone as they are of slight diagnostic value. Most jejunal ulcers are extremely difficult to record on a roentgenogram, even after they have been located on the screen. Under present conditions, radiologists should not make a diagnosis of organic lesion in the intestinal tract unless it has been visualized on the screen, *i.e.*, direct evidence must be forthcoming.

The value of the examination is in no way lessened because a distinction between, for example, a simple and malignant ulcer can not always be made. The hand and eye, properly trained, are of greater diagnostic value than the roentgenogram, and direct evidence of gastric lesions in nearly 100 per cent of cases is, he believes, possible in the near future if this fundamental fact is thoroughly grasped and recognized.

H. J. ULLMANN, M.D.

Secondary Jejunal Ulcers and Their Radiological Diagnosis. S. Gilbert Scott. Lancet, July 31, 1926, CCXI, 222.

Effect of radiation on teeth and mandible.—The observation of several cases of injury following irradiation of the region of the mouth, teeth and mandible induced the author

to study experimentally the effect of X-rays and radium on teeth and mandible in rats and dogs. It appears that the rays injure the odontoblasts chiefly in the germ zone. No changes in the cement were seen. The growth of teeth in young dogs may be stopped by irradiation; the teeth may even fall out; the periodontium, alveolar process and bone marrow show pathological changes. Following 2 to 5 E.D., the mature molars of rats show atrophy of the pulpa. Clinical studies were done on patients who received treatment over the mouth region and on young children whose mothers had been irradiated over the pelvis during pregnancy. In the first group the electrical reaction of the teeth was still positive, while definite injury could be demonstrated by other methods. This is explained by a low sensitivity of the nerve tissue to radiation; in the second group, the dentition appeared to be delayed.

E. A. POHLE, M.D.

Effect of Roentgen Rays and Radium upon the Mandible. M. Leist. Strahlentherapie, 1926, XXIV, 268.

Mustard oil as sensitizer in radiotherapy.—Basing his experiments on the well-known effect of hyperemia, heat, and iodin on the action of roentgen and radium rays upon the skin or tissue, the author recommends the use of an alcoholic solution of mustard oil as sensitizer in accessible tumors before irradiation.

E. A. POHLE, M.D.

Regarding Radiotherapeutic Sensitization with Mustard Oil. G. Schwarz. Strahlentherapie, 1926, XXIII, 702.

Study of colon.—The responsibility of a reliable and complete report of the pathology of the colon depends on the roentgenologist. The clinical evidence is frequently meager and proctoscopic examination is limited to only a small area of the colon. Repeated examinations of the colon after the barium meal as well as after an opaque enema should be made. The mobility, size, shape, position, obstruction, adhesions, possible filling defects and other suggestive findings can be determined. The rectal ampulla should be carefully observed and the passage of the barium into the pelvic colon noted; lowering the head of the table and rotating the patient often facilitate the examination. A localized spasm should suggest inflammatory conditions, possibly diverticulitis. While there is almost always some hesitation at the flexures, this should not persist. The ascending colon usually fills easily and the cecum should be carefully studied for mobility, position, spasm and filling defect. The high percentage of colonic pathology in roentgen findings can be eliminated by careful and repeated colonic examinations.

T. R. MORAN, M.D.

Technic for Roentgenological Study of the Colon. W. O. Upson. Am. Jour. Roentgenol. and Rad. Ther., November, 1926, p. 419.

Malignancy in lower urinary tract.—The author deals with difficulties met with in the treatment of this condition as it has occurred in his service in the Department of Urology in the Royal Victoria Hospital, Montreal.

The operability and prognosis in treatment of bladder and prostate malignancies depend, like cancer elsewhere, on the nature, extent, and location of the growth, on the earliness or lateness of the diagnosis, and on the type and character of the treatment.

The type of treatment adopted in the author's service comprised fulguration, cautery, radium, excision, coagulation, and deep X-ray, used in combination of two or more. He does not believe that high frequency currents are of any use in carcinoma of the bladder, or in multiple advanced fibro-epitheliomatosis or tumors about the vesical neck. In extensive papillomata of the bladder the cautery, through suprapubic incision, gives very satisfactory results. In removing tumors of the bladder radically by the suprapubic route the operator must develop a technic which will prevent cancer implants on denuded areas. When radium was used the author preferred emanation seeds inserted through a hollow needle. When deep X-ray was used four

treatments were given, each technic being—200 K.V., 5 ma., 16 inches distance, 60 minutes, filter 1 mm. copper and 1 mm. aluminium. One exposure was given over the pubis, one over the sacrum, one over the right and one over the left sacro-iliac joint. The entire series was repeated in six weeks.

Cancers of the prostate and trigone, since they are associated with urinary retention, and prostatism, usually require surgical interference to relieve retention. The type of operation will depend on the degree of involvement. The tumor may be enucleated suprapubically, or radium needles may be inserted through the suprapubic opening, or through the perineum, followed later by deep X-ray. The method giving the best results in the author's hands was Young's radical peritoneal prostatectomy.

The results in cancer of the prostate and trigone are variable, depending not so much upon the malignancy of the tumor, as defined by the pathologist, as upon the degree of immunity possessed by the patient, which latter is an unpredictable factor.

L. J. CARTER, M.D.

Malignant Growths of the Lower Urinary Tract. David W. MacKenzie. Can. Med. Assn. Jour., August, 1926, p. 909.

Roentgen therapy in pelvic inflammatory diseases.—Clinical experience seems to indicate that temporary sterilization is the better method of treating pelvic inflammatory diseases where menstruation aggravates the process.

E. A. POHLE, M.D.

Concerning the Treatment of Inflammatory Diseases of the Adnexa, Particularly of Gonorrhea, with Roentgen Rays. W. Baer. Strahlentherapie, 1926, XXIV, 315.

Rous chicken tumor.—In previous publications, the authors have shown that it is possible to give a lethal dose of X-ray *in vitro* to mouse or rat tumors with a fair degree of accuracy. They called this dose "L." and it is the minimum amount that will prevent growth of the tumors when they are reinoculated into normal susceptible animals. A rapidly growing tumor requires a little more (about 10 per cent) radiation than a slowly growing one of the same variety. Jensen's rat sarcoma and five other standard tumors have been repeatedly tested and none required more than the Jensen L. + 30%.

Nearly ninety human carcinomata and sarcomata have been treated by inoculations with X-rayed autologous tumors with the object of immunizing them against recurrence. The dose was 2 L. None has grown after this dose. Eleven varieties of carcinoma and twelve of sarcoma are listed as having been dealt with by this method. This shows that between 1 and 2 L. is uniformly "lethal."

They found, however, that 5 L. have no effect on Rous sarcoma nor 3 L. on the filtrates. One L. *in vivo* has no effect on the tumor. These findings are so important that the concluding paragraph is given in full.

"It may be considered from these experiments that very large doses of X-rays (five times that needed for a lethal action on other malignant growths) appear to have no appreciable effect on Rous's chicken sarcoma. Other experiments show that the virus of this tumor when treated separately is very resistant to X-rays. If a similar virus was present in malignant growths in the mouse, rat, or man, we should have to explain why a dose of X-ray would prevent the growth of these tumors, while five times as much has no effect on the growth of Rous sarcoma. It may be that the animal tumors do not contain a similar virus to the Rous, but its susceptibility to X-rays depends upon the tissue in which it exists, or that there is some substance, at present unrecognized, essential to the growth of these tumors, which is easily affected by X-rays."

H. J. ULLMANN, M.D.

The Effects of X-rays upon Rous Chicken Tumor. S. Russ and G. M. Scott. Lancet, August 21, 1926, CCXI, 374.

Syphilis of cervical vertebræ.—This is a case report of an unusually produced swell-

ing of the neck. In the left posterior cervical region there was a flat, slightly raised area, extending downward and backward from the tip of the mastoid process. It was not nodular or tender but felt of a rubbery consistency. This mass gave rise to radiating pain up behind the left ear and down over the left clavicle. Over the inner third of the right clavicle was an oval swelling the size of a peach stone. The blood Wassermann was triple positive on two occasions. X-ray examination showed a definite thickening and roughening of the periosteum of the left transverse processes of the third and fourth cervical vertebræ, and also of the inner third of the right clavicle.

L. J. CARTER, M.D.

Syphilitic Periostitis of the Cervical Vertebræ and Right Clavicle. L. C. Montgomery. Can. Med. Assn. Jour., May, 1926, p. 563.

A rare compound dislocation.—The writer gives a case report of a condition concerning which there is very little to be found in the literature, namely, compound dislocation of the lower end of the ulna accompanying a long oblique simple fracture of the lower end of the radius. The attempt to find record in the literature of a similar condition elicited the information from the Editor of the *Journal of the American Medical Association* that he could find no record of any case of compound dislocation of the lower end of the ulna. Stimson's "Fractures and Dislocations" reports one case.

L. J. CARTER, M.D.

Compound Dislocation of the Lower End of the Ulna. S. H. Corrigan and C. E. Corrigan. Can. Med. Assn. Jour., June, 1926, p. 689.

Pirquet reaction and roentgen-ray exposure.—The authors studied the influence of roentgen rays upon the Pirquet test. They used a spark gap of 28 to 30 cm., 0.0 to 1.0 Al., one-eighth, one-quarter, one-half, one, two, six, and twelve X. It appeared that after high doses in 70 per cent of all cases, the reaction was very feeble, while in 67 per cent of the patients exposed to small doses the reaction showed a marked increase. The maximum of the decrease could be noted seven to fourteen days after the exposure; if twenty-one days had elapsed, no effect at all was evident. In three cases, a diluted solution was used for the test which did not cause a positive reaction but appeared after irradiation with one-quarter X. These observations bring up again the question of the stimulating effect of small doses of roentgen rays, and should encourage further study.

E. A. POHLE, M.D.

Changes of the Pirquet Reaction under the Influence of Various Doses of Roentgen Rays. J. G. Liebersohn and I. I. Schimanko. Strahlentherapie, 1926, XXIV, 343.

Roentgen rays in asthma.—The authors treated 35 cases of bronchial asthma with roentgen rays, partly exposing the lungs through several fields, partly treating the spleen, and also using a combined exposure, 20 to 25 per cent E.D. through 4.0 Al. per field being given. Although one cannot speak of a cure in these cases, the symptomatic improvement warrants further study of this therapy.

E. A. POHLE, M.D.

The Roentgen Treatment of Bronchial Asthma. V. Kogan-Jasny and Th. Abramowitsch. Strahlentherapie, 1926, XXIV, 336.

Extracranial carcinoma.—Two cases of tumors of the gasserian ganglion are added to the already reported cases, bringing the literature of this rare newgrowth into a comprehensive review, further amplified by an extensive bibliography. X-ray examination in one case revealed "no abnormalities except a loss of outline of the lower border of the left orbit and cloudiness of the left ethmoid cells," and in the other "normal frontal sinuses, some haziness of the ethmoid cells and a definite opacity of the right antrum." Deep X-ray therapy was administered in both cases, fol-

lowing operation, but without staying the progressive course of the disease.

Of their etiology, symptoms, and treatment the author summarizes as follows: "The majority of these tumors originate in the dural sheath of the ganglion or involve the ganglion by direct pressure from contiguous regions in the middle fossa or petrous portion of the temporal bone. A few are primary nasopharyngeal tumors which erode the floor of the middle fossa, and infiltrate the ganglion by direct continuity. Rarely the lesion is metastatic from a distant focus. . . . Involvement of the gasserian ganglion should be considered established when pains of great intensity resembling those of trigeminal neuralgia are associated with areas of anesthesia in the face. Paralysis of the motor branch of the fifth nerve or of other cranial nerves is a rather common confirmatory finding. Although the majority of gasserian ganglion tumors are irremovable, section of the sensory root should be performed to relieve the terrible pain which is an almost constant symptom."

M. INGLEHART.

Tumors of the Gasserian Ganglion, with the Report of Two Cases of Extracranial Carcinoma Infiltrating the Ganglion by Direct Extension through the Maxillary Division. Max M. Peet. Surg., Gynec. and Obst., February, 1927, p. 202.

Roentgen rays in inflammatory disease.—During the recent meeting of German Scientists and Physicians, a surgeon, a gynecologist, and a roentgenologist presented in a survey their viewpoints and experience regarding the treatment of inflammatory diseases with roentgen rays. In the same issue of *Strahlentherapie*, two Russian investigators reported their results in this work, and it seems logical to abstract these papers on the same subject together.

Heidenhain, in whose clinic some of the pioneer work along this line has been done, emphasizes two points: the dose of roentgen rays used in the treatment of inflammatory diseases must always be small, *i.e.*, 5 to 10 per cent E.D. effective in the diseased tissue will suffice; it seems immaterial whether one employs 100 K.V. and 5.0 Al. or 140 K.V. and 0.5 Zn. plus 0.5 Al. The interval between two treatments should be long enough, in other words. It is essential to give the radiation a chance to do its work. How much of the result is due to local or general effect is hard to tell. Large fields are recommended in order to include the surrounding normal tissue. As Heidenhain's experience covers four years with over a thousand cases, 855 of which were followed up, it is worth while to give his statistics. Of his cases, 649 were plus plus or plus (76 per cent); 162 were plus minus and minus (19 per cent); the remaining 46 cases (5 per cent) could not be reached ("plus plus" and "plus" indicate good cases, healing without surgical intervention; "plus and minus" marks indicate questionable results and a "minus" sign represents the negative results).

Wagner considers the following gynecological conditions as amenable to roentgen-ray treatment: diffuse peritonitis starting from the genital organs, acute gonorrheal pelvioperitonitis, inflammation of the adnexa of any etiology, parametritis, eczema of the vulva, acne and pruritus, condylomata, chronic vulvitis, bartholinitis, and infection of the intra-uterine membrane. The indication for treatment is given in all cases where a conservative procedure seems to be advisable; it is contra-indicated in hydro- or pyo-salpinx. Technic: 180 to 200 K.V., 3 ma., 0.5 Zn. plus 0.5 to 1.0 Al., 23, 30, 50 cm. F.S.D., 12×16 cm. field, 150 to 200 *R* on the skin (approximately 12 to 16 per cent E.D.), intervals of from ten days to several weeks or months. In cystitis, the same radiation is used at 25 cm. F.S.D., one 6×8 cm. field above the symphysis, 25 per cent E.D. on the skin. Sometimes an additional vulva field at 40 cm. F.S.D. and one-sixth to one-fifth of the erythema dose is given. Certain cases require such a field only with a dose of one-third of the erythema dose on the skin, to be repeated in ten to fourteen days. In the superficial conditions (eczema, pruritus, and others) 0.5 Al. at 30 to 50 cm. distance, three times one-third E.D. in weekly intervals is recommended. The

whole series may be repeated in six to eight weeks. Sometimes a filter of 3 mm. Al. is employed. The clinical result is shown in the improvement of the general condition of the local process and of the blood. Not all cases respond and there may be some who show a decline following the treatment. Careful study of all these patients is, therefore, essential. The mechanism of the effect remains to be explained. A good bibliography is given, mostly of German papers.

Pordes, from Holzknecht's laboratory, reports the results of some experiments undertaken in the effort to explain the effect of radiation in inflammatory processes. The irradiation, in a test tube, of an inflammatory exudate taken from frogs shows that the white cells are destroyed selectively. There is a possibility that the products of their decomposition have something to do with the observed effect in patients.

Clinically, he recommends the roentgen therapy of inflammatory diseases of the teeth, chiefly in infections of the apical membrane; in the acute stage the best results are to be expected. A preliminary report dealing with six patients suffering from sympathetic ophthalmia, iritis and blepharitis encourages one to try this type of case further. The technic is: 2 $H = 100$ $R = 15$ per cent E.D. surface dose, 3.0 Al., small fields. No potential or quality of radiation is given. One may assume, however, that 100 to 130 K.V. is probably the correct estimate.

Fraenkel and Nissnjewitsch come to their conclusions, based on animal and clinical investigations, as follows: The effect of small doses of roentgen rays in the treatment of inflammatory diseases is most probably of purely local character, because the bactericidal qualities of the blood cannot be raised by irradiation. This is at variance with the statements of Heidenhain and Fried. Chronic inflammations of the soft tissue may be favorably influenced by roentgen rays. The roentgenotherapy of abscesses cannot replace surgery; it may have, however, a favorable influence in the treatment of such conditions, combined with surgery. The indications for irradiating inflammatory diseases must be established by close co-operation between surgeon and roentgenologist.

Further study of this problem is essential in order that one may arrive at a definite opinion regarding indications, contra-indications and dosage.

E. A. POHLE, M.D.

Roentgen Irradiation and Inflammations. L. Heidenhain. Strahlentherapie, 1926, XXIV, p. 37.

Roentgenotherapy of Inflammatory Diseases in Gynecology. G. A. Wagner. Strahlentherapie, 1926, XXIV, p. 52.

On the Roentgen Treatment of Inflammatory Diseases. F. Pordes. Strahlentherapie, 1926, XXIV, p. 73.

On the Roentgen Treatment of Surgical Inflammatory Processes. S. R. Fraenkel and L. M. Nissnjewitsch. Strahlentherapie, 1926, XXIV, p. 87.

Hydrocephalus simulating brain tumor.—The clinical history is presented of a case of internal hydrocephalus simulating brain tumor. The complaints were severe headaches, vomiting, twitching of the face, and sensation of "pins-and-needles" in the face. Physical examination showed an incipient optic neuritis, bilateral Babinski, normal deep reflexes, coarse tremor of the hands, no inco-ordination, and no loss of muscle tone or power. A ventriculogram, using 120 c.c., showed a large hydrocephalus. The cause of the hydrocephalus is probably the obliteration of the foramen of Magendie. The striking thing about the subsequent history is the entire clearing up of symptoms at the present time, three years following the ventriculogram.

L. J. CARTER, M.D.

A Case of Hydrocephalus Simulating Brain Tumor. Arthur W. Young. Can. Med. Assn. Jour., August, 1926, p. 952.